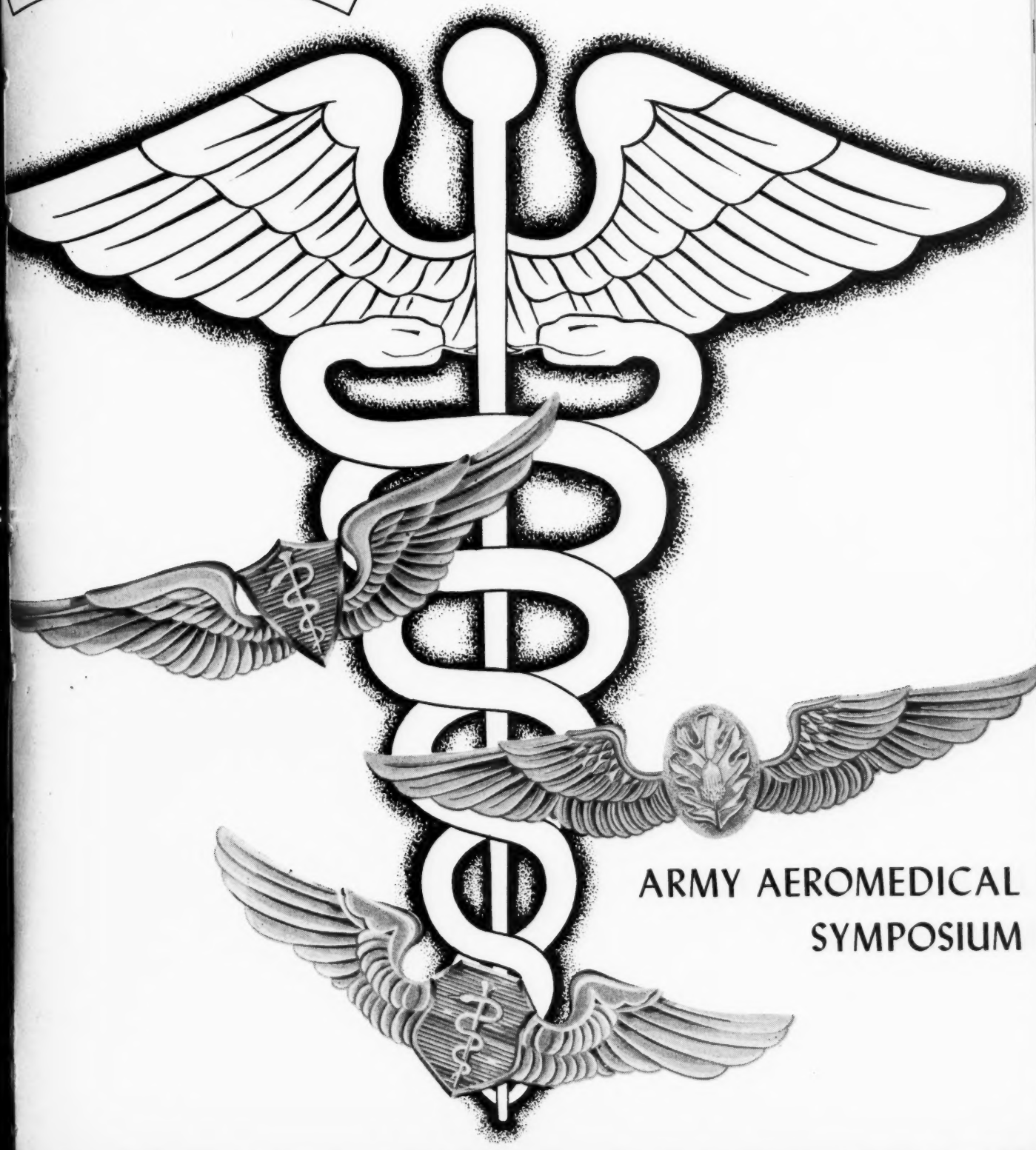
AUGUST 1960

UNITED STATES ARMY AVIATION DIGEST



ARMY AEROMEDICAL SYMPOSIUM

United States Army

AVIATION DIGEST

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The expansion of the Army Aviation Program and the increasing complexity of the aircraft and related equipment places a greater demand on both aviators and maintenance personnel.

As a result, the role of the flight surgeon within the Army Aviation Program assumes ever increasing importance. More technical equipment places greater physical and mental stress on all concerned. The expansion in total numbers of aircraft, aviators, and maintenance personnel, with emphasis on their integration within the frontline elements, further accents the need for a more intensive effort within this vital field.

The First U. S. Army Aeromedical Symposium, as reported in this issue, is another "first" to be added to the growing list within our expanding program. The exchange of aeromedical knowledge will do much towards a better all around aviation medicine program.

The interservice exchange of aeromedical information plays an important role in ensuring that Army Aviation personnel are capable and ready to carry out our vital mission.

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The mission of the U. S. ARMY AVIATION DIGEST is to provide information of an operational or functional nature concerning safety and aircraft accident prevention, training, maintenance, operations, research and development, aviation medicine and other related data.

Manuscripts, photographs, and other illustrations pertaining to the above subjects of interest to personnel concerned with Army Aviation are invited. Direct communication is authorized to: Editor-in-Chief U. S. ARMY AVIATION DIGEST, U. S. Army Aviation School, Fort Rucker, Alabama.

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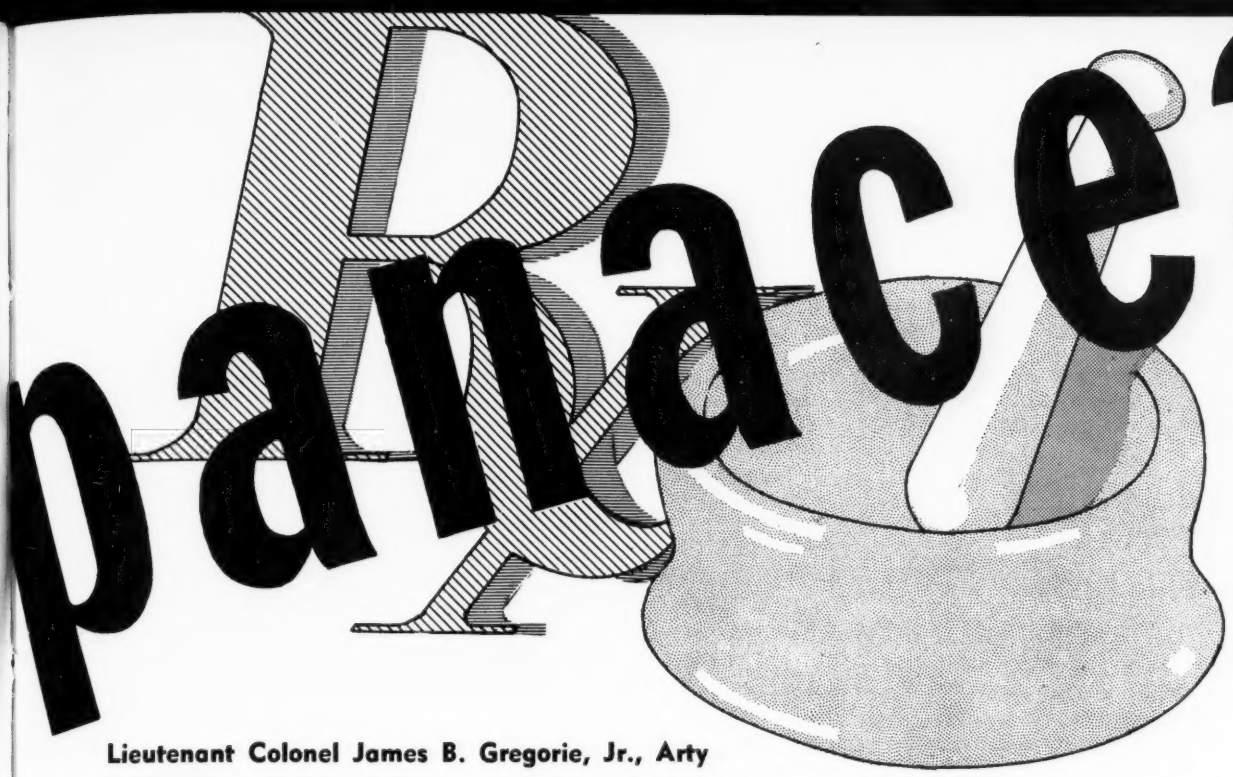
Panacea



Lieutenant Colonel James B. Gregorie, Jr., Arty

"The Army is not interested in the airplane per se. Its interest lies in how aviation can help the Army accomplish its mission. If we lose sight of this objective, and become fascinated by flying from a purely pilot's viewpoint, we are in danger of failing our basic purpose. We must constantly picture the aircraft and pilot in the environment of the soldier, for the mission of Army Aviation is based on the mission of the Army.

"With this mission it seems ridiculous to limit ourselves to some one branch of the Army — to an Army Air Corps. We would be selling ourselves and the Army short . . . There certainly may be a requirement for personnel who devote their entire careers to aviation matters.

"In the longer view, however, just as we now argue that the Air Force has no monopoly on flying machines because they fly, similarly no one branch in the Army should have a monopoly."

Brig Gen Clifton F. von Kann, USA
Director of Army Aviation

IN THE FALL of 1957, the Officer Fixed Wing Aviator Course conducted by the Army Aviation School was lengthened eight weeks to include instrument flight qualification training. Since then, this instruction has been known as Phase "C" of that course. All OFWAC students receive it, even though they are rated as Army Aviators prior to its beginning.

Many opinions have been expressed concerning the advantages and justifications of this portion of the Army Aviation Program. As an objective which determined the need for this training, the instrument qualification of all Army Aviators has been postponed repeatedly. After having worked towards this goal for several years, we now know that it requires a major effort within every command to renew the ever increasing number of expired tickets and to conduct refresher courses for aviators who are either unable or unmotivated to maintain their instrument proficiency.

Experience to date apparently establishes the fact that any future rescheduling of this objective must be predicated upon a foreseeable inventory of Army aircraft adequately equipped to support it. The Army would then be required to have as great a majority of aircraft fully adaptable to instrument flight as are now counted not suitable for instrument training or instrument flight on Federal airways. Such an inventory is far in the future.

The light observation aircraft programmed for the 1970 Army does not include a radio package which will permit its operation in the CONUS under instrument conditions. In this

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Colonel Gregorie is Director, Dept of Advanced Fixed Wing Training. An aviator since 1942, he is dual and twin-engine rated and instrument qualified.

light, further efforts to achieve the instrument qualification of all Army Aviators would appear to be indefensible. Reports from field units indicate that a canvass of an OFWAC class which completed its "C" phase two years ago would reveal that only a small number of its members still in service have maintained their instrument ratings continuously and are now assigned to units where they are required or even able to participate in reasonably frequent instrument flights.

The point is sometimes advanced by ardent proponents of the current OFWAC "C" phase program that students who complete this training will, in any event, be better contact pilots. This may or may not be true. Such a contention is no more plausible than another consideration, i.e., that an unused and neglected instrument qualification when and if put to the hard test of actual performance, may be an extremely dangerous thing.

The future of Phase "C" of the OFWAC may be dealt with as a singular matter; however, other pressing problem areas within the overall Army Aviation Program suggest a composite solution as a best course of action. These additional problem areas are discussed below.

The Director of the Department of Maintenance, USAAVNS, recently stated: "If we don't do something about aircraft maintenance within the combat arms during the next three or four years, we're going to be out of business." Such a conviction is shared by many others. Since the Army assumed responsibility for third and fourth echelon aircraft maintenance, the extent and volume of productive first and second echelon maintenance accomplished by field units have progressively diminished.

This cannot be explained entirely by the introduction of more complex aircraft. Furthermore, blame wherein the Transportation Corps is accused of a grasping attitude or the combat arms are accused of default will not mitigate a progressively worsening situation. Low aircraft availability rates, records of inordinate uses of emergency parts requisitioning procedures, and repeated examples of dangerous and wasteful maintenance practices are too prevalent today in Army Aviation.

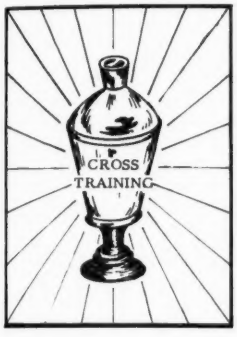
It is paradoxical that throughout the history of Army Aviation, despite the adoption of more complex aircraft, the percentage of ground school time allotted to aircraft and engine maintenance within what is now the Officer Fixed Wing Aviator Course has steadily decreased from nearly 100 percent to less than 25 percent. Today over 80 percent of the latter is conducted at the Army Aviation School within the Department of Primary Fixed Wing Training. The result of this—and the real heart of this problem area—is poor maintenance supervision or, more accurately, the near lack of any of it.

At one time the Army Aviation School conducted an Organizational Maintenance Officer Course. That course was first conducted over a 10-week period, then reduced to 5 weeks, and finally eliminated because of little or no support from field units. A new approach must be found which will provide adequately trained officer supervision of organizational aircraft maintenance.

This is not a problem of numbers but of training. A full discussion of a division aviation company cannot be undertaken here; however, a brief consideration of an Aerial Surveillance Platoon is sufficient to illustrate a serious problem area. No established provision or responsibility exists within the entire Army school system today for the training of Army Aviators to be assigned to these units in the characteristics, capabilities, limitations, and approved doctrine pertaining to the photographic, electronic and drone equipment found therein. The amount and the cost of this equipment is impressive, but its potential, dependent upon the efficacious **training** of the officer Army Aviators in command, is of foremost importance. Combat surveillance and target acquisition will inevitably be a prime, day-to-day mission of Army Aviation if and when our modern divisions maximize their abilities on atomic or conventional battlefields—their areas of influence.

We have for some time spoken in glowing terms of an "all-weather operation." Within that concept where is the training being provided for those who must decide when and why to use an L-19, an H-13, a Mohawk, a drone SLAR, infrared devices, or conventional photog-

raphy? As an illustration I will use only the aerial surveillance platoon of the aviation company with its visual and photo surveillance section, aerial radar section, drone section (a formidable unit in itself), and its radar tracking and plotting teams. The operations platoon with its air traffic control section and its approach control section (not to mention the remainder of the company) will present requirements and problems of similar complexity that can be resolved only by additional training of key personnel—Army Aviators! In view of what **must be done** as contrasted to what **is being done,** one might realistically observe, WE ONLY TEACH THEM TO FLY!



Apparently there is no determinable pattern to the training of fixed wing Army Aviators in helicopters. Some student officers completing the OFWAC's "C" phase at the Army Aviation School have been ordered directly to the Army Primary Helicopter School at Camp Wolters for rotary wing training. Other Army Aviators, after years of experience and repeated requests for helicopter training, continue to be reassigned without it. The helicopter training of fixed wing Army Aviators should be programmed ideally between their third and sixth year within the Army Aviation Program — for those who demonstrate a high potential to the program. Similarly, officers who have been initially rated as rotary wing Army Aviators, and who can be expected to progress in the Army Aviation Program to supervisory assignments involving both fixed and rotary wing operations, should be scheduled for cross training and fixed wing qualification.

The Aviation Staff Officers Course (ASOC) as conducted within the Army Aviation School is an excellent course. Unfortunately, it appears to have little appeal to field units or it suffers the severe competition for TDY funds felt by all other short courses within the Army school system.

It is often said that the ASOC is presented on the Command and General Staff College level. This is not bad in itself, but it does give rise to the observation that a vast amount of learning necessary must presumably be accomplished by Army Aviators in the hard and unstandardized school of field experience between the OFWAC and the ASOC courses. The Army Aviation Program would definitely benefit if a portion of the current ASOC Program of Instruction (or a similar course emphasizing operations on the divisional and lower levels) were presented as an adjunct to an established PCS course having a greater attendance than the present ASOC.

This question has been debated by more people more ardently than any other facet of Army Aviation. The obvious lack of an agreement among Army Aviators themselves, without considering the myriad opinions found Army-wide, is sufficient to establish the fact that neither of these ideas is satisfactory **per se** at present or holds any great promise for the orderly development of Army Aviation. Unfortunately the majority of opinions in this area represent either one extreme or the other. Most often they are as impassioned as they are parochial.

Some views reflect visions of Army Aviation which include numbers of zero ground-pressure vehicles scurrying over battlefields like the ubiquitous jeep of today, piloted by privates. Others are dominated by the Artillery pilot as an Artillery officer adjusting artillery fire from an Artillery aircraft. In a third imaginative picture of Army Aviation ten years hence, aircraft of a complexity yet to be devised are crammed with electronic systems which, in conjunction with equipment of the ground of equal complexity, provide control and effect the reporting of data to super UNIVACs that will for all intents and purposes supersede the G2 estimate and the FSCC.

Can Army Aviation present a different face and provide a peculiar service to all who demand a specialized mission? It can be done if a realistic appraisal is made of three basic concepts now involved and a plan is formulated to reckon with the parts of each in turn. However, neither

an aviation branch nor insistence upon a singular branch proficiency for aviators will permit this. These concepts are prime facets of the Army Aviation program which, because of their innate inflexibilities, are not congruous. They generate waste and preclude satisfactory solutions to their own requirements.

The first concept is the universal instrument qualification of all Army Aviators as an unmitigated objective. **The second** includes a mandatory branch proficiency for all Army Aviators that must be equal to that achieved by their nonflying contemporaries. **The third concept** is a policy wherein existing branch identities are so sacrosanct that a multitude of what should obviously be branch immaterial assignments are reserved to Transportation Corps aviators. This same policy tends to divide Army Aviators into two camps with loyalties and objectives so diverse they constitute a real deterrent to the Army Aviation Program.

NO OVERLAP NECESSARY

This unnecessary overlap of concepts has led to our real problems. No overlap is necessary to meet the true fundamental requirements of an Army Aviation program that can best help the Army accomplish its mission.

The instrument qualification of all Army Aviators as an objective and the training program which supports that aim have already been considered. No real need exists for this objective. The requirements for an Army Instrument rating are such that it is awarded only to those who have demonstrated a knowledge of flight planning, air traffic control, and en route and approach flying techniques no less exacting than the requirements placed upon commercial airline pilots. Once awarded, the right to retain the rating must be demonstrated by the successful completion of annual written and flight examinations. If these are not passed, the aviator faces the possibility of elimination from flying status! No branch proficiency is so severely monitored.

The paradox here is that the vast majority of Army aircraft do not require advanced pilot qualification and were procured to accomplish missions which are limited to fair weather operations. In short, we are pushing all Army Aviators toward an instrument proficiency which permits their pilotage of instrument aircraft into the New York or Washington areas as a **routine** IFR operation, while we persist in a concept of tactical operations that includes a preponderance of VFR command liaison flights, aerial artillery adjustments, visual route reconnaissances, etc.

FUNDAMENTAL TENETS

The most fundamental tenet of Army Aviation is that the Army Aviator is a part of an Army unit, completely familiar with that unit's characteristics, responsive to its requirements, and dedicated to the accomplishment of its mission. Army Aviators so closely associated with a unit are required to be branch qualified as a unit member **if it is a combat arms** unit. An artillery commander can logically expect maximum efficiency from the pilot of an aircraft working with his unit if he is a competent Artillery officer capable of making a target appraisal, fire adjustment or assisting an artillery observer in these functions.

Similarly, a branch qualified Engineer aviator's observations are no doubt better received than if the pilot were of another branch. Conversely, an Engineer officer who is vastly more familiar with ILS approach procedures than considerations which determine bridge sites would be of less value. Note that these pilots roles are visual in nature and by and large peculiar to the branch missions illustrated. In such a role, an Army Aviator can maintain a branch proficiency tantamount to that of his fellow officers in the unit to which he is assigned or supporting—and the opportunity for him to do so should be provided! On the other hand, when an aviator is required to be fully instrument qualified it must be recognized that the new requirement is completely foreign to the task of continuing his branch proficiency, is of equal or even greater difficulty, and affords little or no advantage to the latter. Any attempt on the part of an Army Aviator to maintain an instrument and a branch proficiency must (and demonstratively has) result in the mediocrity of one or the other. As a result of the stringent requirements of the annual instrument and flight examinations, branch proficiency is the more common sufferer.

I do not advance this argument to pose the question of **Why do we have instrument pilots and instrument aircraft.** An all-weather capability is essential if that **portion** of Army Aviation needed for such foreseeable operations is to contribute its full share towards the accomplishment of the Army's mission. The point to be established is that missions which must be flown without visual references to the ground

rarely, if ever, will require a particular pilot branch proficiency. These missions will demand, however, an instrument flying skill of the first order.

A preplanned Mohawk sortie employing SLAR during instrument weather, with ground track determined by radar vectors, can be flown just as well by a pilot from Transportation Corps as from Infantry.

Promotion into higher command and staff echelons, not only requires an appreciation of ground operations beyond the purview of any one branch, but a closer familiarity with the more complex aviation matters and procedures becomes essential. Their abilities to plan and participate in both instrument and fair weather operations must be firmly established. An insistence upon their continued singular branch proficiency will no longer serve an advantage.

A SOLUTION

An answer to these problems, one which would also pave the way for a reconciliation of the inflexibilities that have been considered, can be developed around a logical expansion of the Army Aviation School's curriculum, the establishment of an Army Aviation Advanced Course, as the first and most fundamental step.

The current "C" phase of the Officer Fixed Wing Aviator Course should be shortened to three weeks. OFWAC graduates would not be instrument rated upon completion of that course. They would, however, have a basic knowledge of instrument flying sufficient for their foreseeable needs as branch proficient aviators. They would be capable of making a course reversal and a ground controlled approach if confronted with adverse weather conditions. They could be expected not to panic if visual reference to the ground were temporarily lost. They could be counted upon to maintain that level of instrument proficiency, along with branch proficiency fully equal to that of their nonrated contemporaries.

The Army Aviation Advanced Course would include in its flight POI extensive instrument qualification training, twin-engine training, and cross training for both fixed and rotary wing aviators. AAAC students would also receive instruction in supervisory maintenance sufficient to qualify them for assignment to Army Aviation positions where such knowledge is essential.

Furthermore, the Advanced Course at the

Army Aviation School would be comparable in scope to other advanced courses, such as those conducted at the Infantry, Armor, Artillery, and Missile schools. It would be scheduled over a similar period and divided into three equal phases.

Although academic instruction would be presented throughout the course, the first phase would include cross training in either fixed wing aircraft or reconnaissance helicopters; the second, instrument and multiengine training; and the third would be devoted entirely to ground subjects. Communications, combat surveillance and target acquisition, the employment of infantry, armor, and artillery, Air Force and amphibious operations, special weapons, and other general subjects would be integrated into the AAAC.

This advanced course would be designed to serve as a prerequisite to the Command and General Staff College for Army Aviators in lieu of existing advanced branch courses!

The number of officers selected to attend the Army Aviation Advanced Course should be geared to the Army's need for aviators with the skills they would acquire in that course—instrument and multiengine pilots, aviation staff officers, and aviation commanders. Upon comple-

Continued on page 19

SYMPOSIUM

Pierce L. Wiggin

WHAT PROBLEMS do Army Aviators face which do not apply to their counterparts in the other services? What contribution can flight surgeons make to the aircraft accident prevention program? What should the flight-surgeon-aviator relationship be? What are the psychological problems of modern aviation? What pretraining tests would eliminate all but the most qualified candidates from aviation training? What impact forces can the human body withstand, and what is the flight surgeon's role in crash injury prevention?

These are some of the questions discussed at the first Army-wide Aeromedical Symposium, Pensacola, Fla., June 8-9. Sponsored by the United States Army Board for Aviation Accident Research, the symposium was held to orient surgeons, hospital commanders, and staff aviators with aeromedical factors in aircraft accidents. Representatives from all major Army commands heard the answers to these questions from leaders in the field of aviation medicine.

Col James F. Wells, Director, USABAAR, and symposium moderator, set the tone for the symposium by expressing this aircraft accident prevention philosophy: "We can improve aviation through accident research. We must learn the human, material, and operational factors which result in accidental loss and correct these in future aviation. Crashed aircraft do not accomplish their missions—dead crews do not fly again."

Colonel Wells introduced Vice Admiral Robert Goldthwaite, Chief, Naval Air Training, Pensacola Naval Air Station, and Rear Admiral J. B. Holland, Commanding Officer, Pensacola Naval Aviation Medical Center, who welcomed Army doctors and aviators to the Naval Air Station and Pensacola area.

Maj Gen Ernest F. Easterbrook, Commanding General, U. S. Army Aviation Center, and Commandant, U. S. Army Aviation School, emphasized the important role Army flight surgeons and psychologists must play to keep aviators at their most efficient level. "Aviation," said General Easterbrook, "is composed of man, machine and environment. This symposium is concerned with man and the problems he faces

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Mr. Wiggin, Chief, Literature Division, USABAAR, was a fighter pilot during World War II. A USAFRes major and a former USAF and USAAVNS flight instructor, he has logged more than 7,500 flight hours.

in the complex aircraft of today and an ever-widening range of missions. Speed and altitude, long considered essential for safe flight, are not always available to the Army Aviator who must learn to fly his aircraft at slow speeds in the nap of the earth."

While all of the data recorded at the Aero-medical Symposium is important, the entire context is extremely long. For this reason, with the help of Captain Quitman W. Jones, Army flight surgeon, and Chief, Human Factors Section, USABAAR, we have extracted what we believe to be those portions of greatest general interest.

Personnel Selection For Flight Training

Lt Col Rollie M. Harrison, Army flight surgeon and Aviation Medical Advisor to the U. S. Army Aviation Center, said: **"The initial step in the care of the flier should be in the selection of personnel for training.** Recognizing the need for high standards of physical fitness in the selection of trainees, only those who can meet these standards should be entered into the training program. Since vision is considered the most important single sense used in flying, those selected for this training should be possessed of keen visual acuity, normal ocular muscle balance, and have normal color vision to be able to properly interpret signal lights and to differentiate terrain features.

"Auditory and equilibratory apparatus should be of high standard in the trainee in order that he can properly interpret radio communications and react normally to the forces experienced in flying which will stimulate the equilibratory portions of the ear. The individual who already has a notable hearing loss is not a good candidate for flying duty.

"Normal respiratory, circulatory and digestive systems are a must for the fledgling pilot, for upon these depend his maintenance of an adequate physical state of well being.

"Emotionally, he should be above average, able to withstand harrowing experiences which will beset him while operating in an abnormal environment, without distracting from his capability to think, plan and make the proper decisions that will enable him to fly his equipment safely and to complete his mission successfully.

"The problems related to flight abnormalities and medical conditions which may affect ability to fly will require application of the finest diagnostic abilities and the best of medical judgment. A condition may be acutely or chronically induced by the stress of flying, or it may have some other cause. In any event, such a condition must be diagnosed, properly treated and thoroughly evaluated with respect to the individual's flying status. In the management of such cases the flight surgeon must be certain to maintain adequate administrative control of the flier to prevent the undesirable happenings which may occur when the unfit fly. Good medical care, close observation, and the proper execution and recording of the periodic medical examination will meet the many problems arising in this category."

ANNUAL PHYSICAL

Colonel Harrison described the various aspects of the annual physical, emphasizing the need for detecting incipient conditions, disqualifying defects, or any neuroses which might develop from nervous strain. He discussed the importance of thorough medical investigations in aircraft accidents and emphasized close coordination between the flight surgeon and safety officer. "The flight surgeon must have a sincere interest in the subject and an active interest in aviation and flying. He must have a practical understanding of the emotional stresses met and the physiological difficulties encountered in flying."

Medical Aspects of Aircraft Accident Prevention

Doctor Charles I. Barron, Medical Director, California Division, Lockheed Aircraft Corporation, and Lecturer, Aviation Safety Division, University of Southern California, said the average person is apt to depreciate the significance of small aircraft and helicopter accidents because of the more spectacular, headline-attracting crashes which result in mass deaths and losses of millions of dollars in property. **Yet, according to Doctor Barron, the accident rate for small aircraft and helicopters is the highest in aviation and in direct contrast to the declining rate of all other military and civilian aircraft.**

"In reviewing accident statistics of small aircraft accidents in military and civilian aviation," said Doctor Barron, "one is impressed by the lack of definitive causes of accidents relating to human or operator failure. In many cases, the type of accident or final maneuver is listed as the cause factor; thus collision with the ground, ground loop, stall, failure to maintain airspeed, or misuse of controls are listed as accident causes. These conditions are not basic causes of accidents, but simply the maneuvers that resulted from an improper action on the part of the pilot. Only occasionally is an attempt made to determine why the pilot lost control of his aircraft, and very infrequently indeed, in these accidents, is a medical factor such as fatigue, vertigo, incapacitation, hypoxia or noxious fumes listed as the basic cause of the pilot's poor judgment or lack of flying skill.

"Accident investigation, per se, is of little value unless the information gained can be used in the prevention of future accidents. This has been accomplished in some aircraft by cockpit reorganization, improved instrumentation, and development of more sophisticated personal equipment. To achieve its greatest utilization, major efforts must be concentrated on the education and training of the human operators, to assist them in better understanding of the aircraft and flight environments so they may more readily recognize and avoid those conditions causing accidents. It is through education and training that the flight surgeon and flight safety officer can achieve greatest results in reducing the incidence of accidents and preventing injury and death of aircrews."

PROFESSIONAL TRAINING

Dr. Barron described the need for a close rapport in the flight surgeon-aviator relationship. He attributed a general improvement in flying safety during the past 10 years to an increased emphasis on flying safety in command and on the line. He described how U. S. military services and some foreign countries have provided professional training for their safety officers. The major part of this training is given during a concentrated 8-week course at the Aviation Safety Division of the University of Southern California (to date, 263 Army officers have graduated from the Army Aviation Safety Course).

"Aviation physiology and psychology are two important subjects in the program," said Dr. Barron. "The intent is to instill an awareness and understanding of the human or medical aspects of accident causation in the safety officer and to give him an accurate appraisal of the flight surgeon's role in accident prevention and investigation. It is hoped that by properly stimulating the flight safety officer, he will, in turn, transmit this basic interest and inquisitiveness to flight crews so that they will better understand the interrelationship of man and his aircraft environment. It is also believed that, as a result of this training, the flight safety officer will be better able to utilize the more definitive medical skills and special talents of the flight surgeon."

COMMAND SUPPORT

Dr. Barron explained a need for intensive education to obtain command support for flight

surgeons and flight safety officers. "A major objective of this training is to instill a better understanding of the role of these key personnel in the general aviation safety picture and to encourage the cooperation and support of those in positions of command. **Once the pilot is convinced that the physician is basically interested in helping him maintain his health and prolong his career rather than to merely determine his ability to pass physical standards, he becomes more receptive to accepting a preventive medical program.**

ACCIDENT CAUSES

"Assuming statistics for accident causation to be essentially similar in all branches of the military services for identical types of aircraft and flying operations," Dr. Barron continued, "we must assume that the most common primary medical causes of aircraft accidents in the Army are as follows: vertigo/disorientation, restricted or hampered vision, fatigue, and temporary incapacitation. Secondary contributing factors are smoke and noxious fumes, carbon monoxide, noise and vibration, poor nutrition, illness and self-medication.

DISORIENTATION

"In military jet aircraft, an increasing number of accidents are being attributed to vertigo or disorientation," he said. "It has been erroneously assumed that disorientation is limited to such aircraft; however, a recent study of Air Force helicopter pilots has revealed an extremely high incidence of disorientation, despite its lack of identification as the actual cause of helicopter accidents. The helicopter is basically an unstable vehicle and difficult to fly; it is easy to understand how spatial disorientation may occur.

"Among the skilled instructor/pilots interviewed in this study, each indicated one or more episodes of disorientation, some classified as severe. The largest number of episodes occurred while flying over unpopulated areas on moonless nights. The lighting of the helicopters, as well as reflection of ground lights inside the cockpit, causes considerable confusion. In several cases, the loss of visual reference at night, associated with misinterpretation of gravitational forces and erroneous sensations of rotation, resulted in considerable disorientation. Among other conditions conducive to disorientation in helicopters, as well as in small aircraft, are night formation flying, sudden transition from visual to instrument flight regulations, flight in instrument weather, and simulated instrument flights under a hood.

VERTIGO

"One of the more common conditions of vertigo in fixed wing aircraft results from sudden movements of the head out of the plane of whole-body rotation with simultaneous stimulation of two sets of semi-circular canals. This situation is likely to occur when pilots orbiting around an airport or landing area, suddenly turn their heads to change radio channels. This phenomenon in high performance aircraft is extremely dangerous, as it usually occurs at low altitudes, and pilots correcting for the apparent movement of the aircraft may compromise control of the plane while close to the ground and at relatively slow speed. The pilots in this study made a number of suggestions for prevention of disorientation, such as better instrumentation of the cockpit and increased training with emphasis on night instrument flying. **They further recommended that all pilots experience disorientation under controlled conditions.**

FLICKER VERTIGO

"The interesting condition of flicker vertigo results when the rays of the setting (or rising) sun passing through slowly revolving rotors or propeller blades produce photic stimulation at 10 to 14 flickers per second in hypersensitive persons. [See AVIATION DIGEST, November 1959, page 26.] In a few cases, cerebral excitation, seizures, and unconsciousness have occurred.

RESTRICTED VISION

"Restricted or hampered vision occurs under weather conditions such as fog, rain, clouds and snow, or when oil sprays on the canopy or smoke is in the cockpit. Visual impairment as a cause of aircraft accidents and midair collisions in high performance aircraft has become extremely important. There is even a case on record of a midair, head-on collision of two helicopters which occurred during daylight hours in clear weather. It is anticipated that without proper traffic control and adequate training of flight personnel, midair collisions will be of increasing importance in Army Aviation as the number of aircraft and their speed increase during the coming years.

Continued on page 22

"Theoretical Analysis of Light Plane Landing and Takeoff Accidents Due to Encountering the Wakes of Large Airplanes"
With "Rough Rules-of-Thumb for Safe Separation"
Report No. SM-18647, Santa Monica Division
by Zegmond O. Bleviss
Douglas Aircraft Company, Inc.
— and —
"A Preliminary Study of the Effect of Jet Blast or Wake on Other Aircraft"
By Beech Aircraft Corporation

From the Douglas Aircraft Co. Report:

MANY ACCIDENTS AND near accidents have been caused by light planes encountering the wakes of large airplanes during landing and takeoff even though normal separation times were observed. The two typical difficulties generally reported by the pilots of the light planes were: a sudden violent roll (in either direction) accompanied or unaccompanied by a sudden large "apparent" loss of lift characterized by rapid loss of altitude. These accidents have been generally attributed in some obscure way to the prop wash or to the turbulence created by the large airplane.

TRAILING VORTEX SYSTEMS

It is shown that the accidents are caused by the rotational field of air associated with the rolled-up trailing vortex system from the wing of the large airplane. The suddenness of the onset of the difficulties is due to the unexpected entry of the light plane into this vortex system.

Detailed numerical results are presented for a typical example consisting of a DC-6B as the large airplane and a 40-foot span light plane (whose other characteristics are unspecified). The presentation permits the calculation of similar results for any other combination of large airplane and light plane. The roll rate and the average down-wash (rate of loss of altitude) which are induced on the light plane wing are investigated, as well as the time variations of these quantities as viscosity, small-scale turbulence, gustiness, wind and ground effects exert their influences.

The magnitudes of the roll rate and apparent loss-of-lift effect that the light plane can

Reprinted from a FLIGHT SAFETY FOUNDATION report of January 1956.

experience depend principally upon two things. These are the intensity of the velocity field created by the rolled-up trailing vortices and the position of the light plane relative to the vortices. A number of factors which affect the velocity field and the positions of the vortices are investigated.

The initial velocity field and positions of the vortices (i.e. just aft of the large airplane) depend upon the wing span, speed, weight, and spanwise lift distribution of the large airplane. The velocity field of the vortices will vary with time. The positions of the vortices will change with time, the vortices moving under the influences of their mutual interactions, ground effects, and winds.

"RULES-OF-THUMB"

Because of the many factors involved and because much of the required data would not be known in any typical situation, no detailed rules can be set up which will allow pilots of light planes to avoid difficulties under all conditions. However, certain rough rules - of - thumb concerning separation times necessary to assure "safe" conditions are formulated for combinations of large airplanes and light planes of the class considered in the example. For large airplanes which differ greatly from the DC-6B, corresponding rules-of-thumb can be rapidly estimated.

CAUSE OF THE ACCIDENTS

The large airplane in passing through the air leaves behind a wake of disturbances. These disturbances arise from numerous sources on the airplane. To determine which of the many disturbances cause the accidents it is necessary to condense from the accident reports the significant characteristics of these accidents and then to deduce from them the properties which the disturbance must have. It will be seen that these characteristics are such that the accident - provoking disturbance can be readily identified.

A study of the accident reports reveals:

1. The disturbance must be able to induce large roll rates (in either direction) and large apparent losses of lift (characterized by rapid loss of altitude) on smaller aircraft varying in size from the smallest light planes to at least those with wing spans somewhat greater than the wing semispan of the large airplane.

2. The induced effects on a light plane are about the same whether the large airplane is landing or taking off.

3. The disturbance can persist for several minutes.

4. The disturbance is not random.

The disturbance velocity field must be approximately independent of whether the large airplane is landing or taking off. The steady rotational character of the disturbance field reduces the possible sources of the disturbance to either the propellers (i.e. the rotation in the propeller slipstreams) or the trailing vortex system from the wing of the large airplane. The fact that the intensity of the rotation in the propeller slipstreams differs greatly for landing and take-off and the small lateral extent of each propeller disturbance field (of the order of magnitude of the propeller diameter) eliminate the propellers as possible sources of the disturbance. Then the tentative conclusion is that the disturbance is caused by the trailing vortex system from the wing of the large airplane.

The proof of this conclusion, of course, will be to show that the trailing vortex system can induce large roll rates and apparent lift losses on a light plane and that the disturbance can persist for several minutes.

It should be noted that the abrupt onset of the difficulties which the light plane experiences is not a characteristic of the disturbance, but is due to the fact that the light plane flies into the disturbance unexpectedly.

OPERATIONAL PROCEDURES

No simple operational procedures can be devised to assure normal separation times for the landing or take-off of a light plane following the take-off of a large airplane except for the limiting case of zero parallel wind component, for which condition the landing and take-off procedures should be clear from the foregoing discussion. However, some suggestions can be made for increasing the chances of recovery should the vortices be encountered.

The basic idea is that the light plane should always have sufficient air speed for effective maneuvering. In landing, reasonable air speed should be maintained until contact (i.e. power landings). The following operational procedure is suggested for take-off:

Following lift-off, the light plane should fly near the ground, picking up air speed before climbing. This procedure is suggested by the fact that most of the vortex system is more than about 40 feet off the ground. Thus any chance encounter with the vortex system

is delayed until better maneuvering air speed has been obtained.

From the Beech Aircraft Corp. Report:

(Based on extensive studies of published data and inquiries among representative Government agencies, aircraft manufacturers, pilots, engineers, and other leading authorities.)

The disturbance created by the trailing vortices of an airplane, the jet wake, and the sonic shock wave can have detrimental and, under certain conditions, a destructive effect on another airplane.

Structural loads of 9 G's have been recorded in a transit through a jet wake with fighter-type aircraft; and a light plane traveling at 100 mph about 1 mile aft of a jet bomber recorded positive loads of 2.5 G's and negative loads of 3.5 G's when intercepting a vortex wake at about 90 degrees.

The turbulence created by some types of aircraft and under certain weather conditions can be violent to severe as far as four miles aft of the plane causing the wake.

The sonic shock wave has been known to knock out windows and do other damage and appears to be a possible hazard under certain combinations of conditions.

The flight practices which allow or cause close maneuvering of either jet or propeller-driven aircraft of high speeds, high wing loadings and/or large size, and smaller aircraft can cause a safety hazard.

Listed below are two of the many conditions that could produce structural failures:

1. If a small plane, flying at cruise speed, observes a jet aircraft and executes an evasive maneuver which increases the load factor to approximately its design value, then the penetration of the wake area could produce load factors in excess of the design values, with structural failures resulting.

2. If two or more aircraft are flying in formation, or close proximity, the combined effect of the wakes could produce structural failures in the small aircraft.

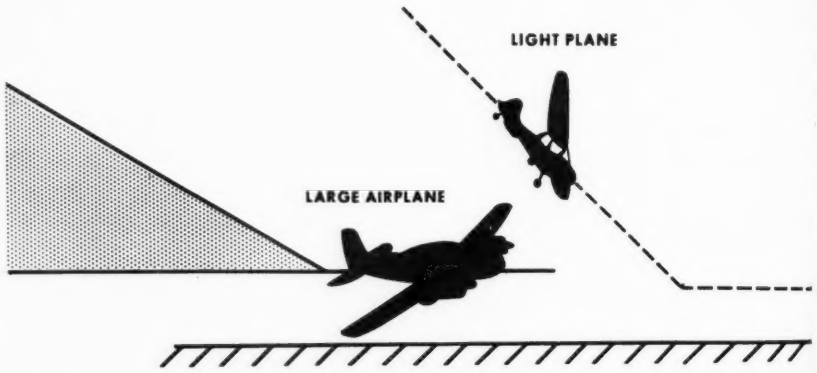
ROUGH RULES-OF-THUMB FOR "SAFE" SEPARATION TIMES FOR THE LANDING OR TAKE-OFF OF A LIGHT PLANE FOLLOWING THE LANDING OR TAKE-OFF OF A LARGE AIRPLANE

(Reference: Douglas Report SM-18647, Dec., 1954)

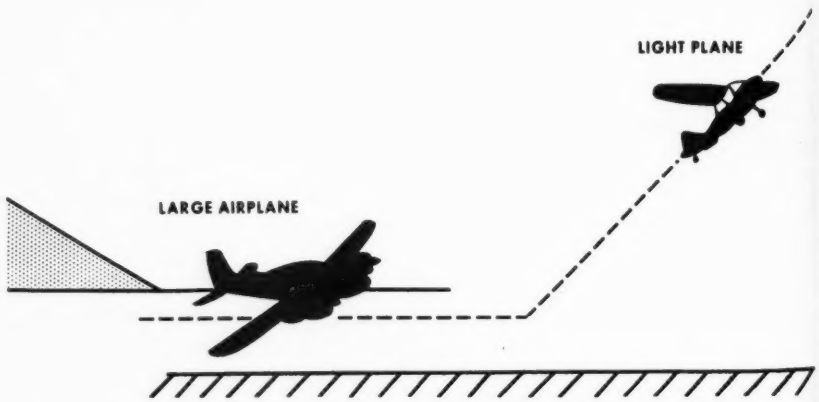
Example: With a large airplane **landing** under **any wind condition** normal separation time for a light aircraft would be about 30 seconds if it operates as shown in sketches below.

Example: With a large airplane **taking** off in a **direct crosswind,** the normal separation time for a light aircraft would be about 30 seconds if it operates as shown in the sketches below.

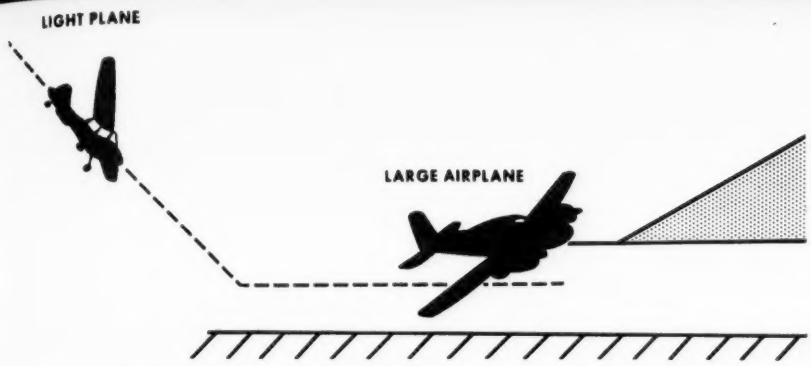
Example: With a large air-



Light Plane Landing: Light plane should stay well above the flight path of the large airplane and should contact the runway well forward of the contact position of the large airplane.

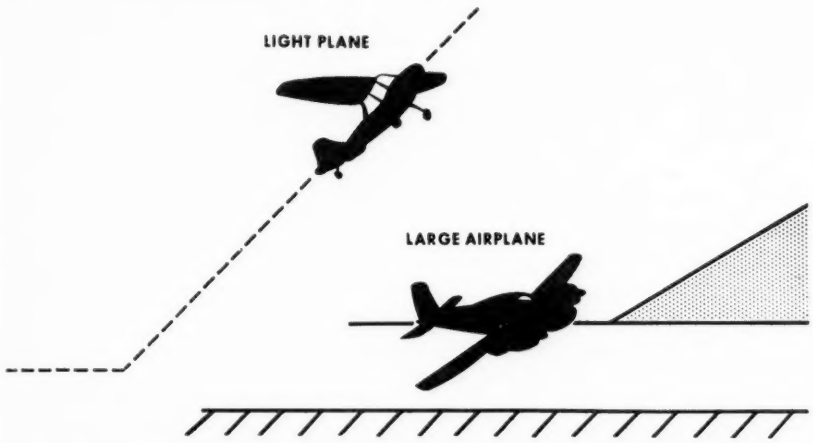


Light Plane Taking Off: Light plane should delay lift-off until well forward of the contact position of the large plane.



Light Plane Landing: Light plane should contact the runway well to the rear of the lift-off position of the large airplane.

plane taking off or landing in a general crosswind (excluding the direct crosswind) the "safe" separation time for a light aircraft now depends mainly upon the wind component across the runway (see definition table below) and the characteristics of the large plane.



Light Plane Taking Off: Light plane should lift off well to the rear of the lift-off position of the large airplane and should stay well above the takeoff flight path of the large plane.

The following rules apply to larger airplanes of the DC-3, DC-6, and C-124 classes (light plane taking off or landing).

Example: With wind component across runway greater than 10 mph, safe separation time would be about 30 seconds.

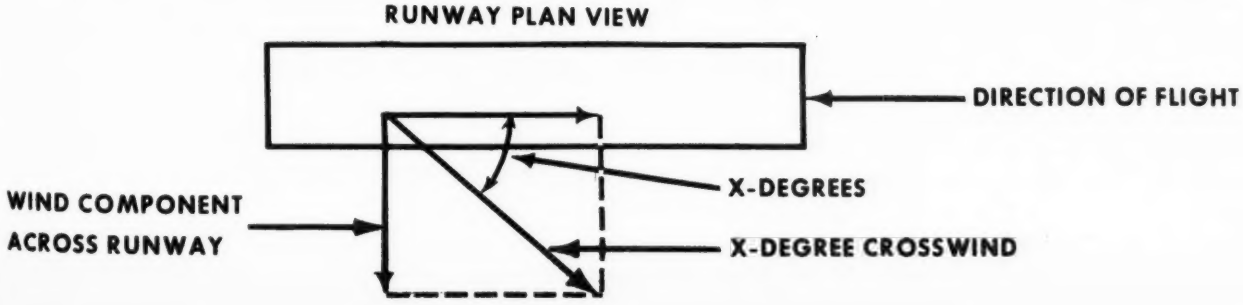
Example: With wind component across runway between 2.5 and 7 mph, safe separation time would be between 5 and 10 minutes.

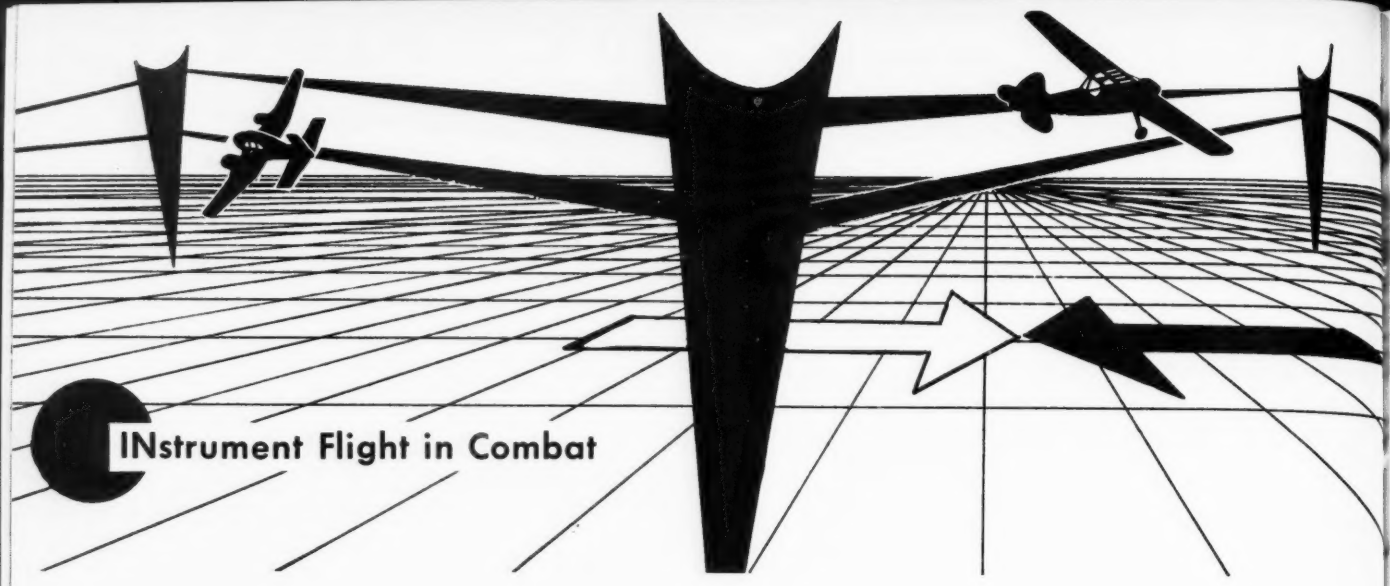
Example: With zero wind component across runway (wind directly along runway) safe separation time would be 2 minutes.*

*NOTE: It should be emphasized that these are approximate separation times which are necessary in order that there be **very little chance** of encountering difficulties. For shorter separation times difficulties will not **necessarily** be encountered but the chance of running into trouble is **much greater.**

DEFINITION OF WIND COMPONENTS:

A WIND COMPONENT ACROSS THE RUNWAY OF	CORRESPONDS TO A		
	10-DEGREE CROSSWIND OF	20-DEGREE CROSSWIND OF	30-DEGREE CROSSWIND OF
2.5 MPH	14.5 MPH	7.5 MPH	5 MPH
7 MPH	40 MPH	20.5 MPH	14 MPH
10 MPH	57.5 MPH	29 MPH	20 MPH





INstrument Flight in Combat

Captain John P. Johnson, Inf

THE FUTURE CONCEPT of all-weather or limited weather capability for Army Aviation is the topic of many articles and conferences. Not all Army aircraft are equipped with anti-icing or deicing equipment. Severe thunderstorms in the area of operation and heavy or extended rain affect or limit our flight capability. These problems are being studied and a solution will probably be advanced in the near future.

At times we have been called upon to fly in adverse weather; it is a tribute to the Army Aviators' proficiency in instrument flying that those missions were, to a great extent, successfully completed. We will have to carry this high degree of proficiency over into combat, but in all probability we won't have all of the exotic equipment found at most airfields today. Equipment such as VOR/DME, permanent or semi-permanent GCA, high intensity approach lights, bright runway lights, rotating beacons, and prepared approach lanes will not be available to us under combat conditions. I cannot imagine a commander allowing these in his zone, even if time were available to install them. I'm afraid that the only equipment available will be a homer beacon, quadradar, and some sort of portable or homemade lighting equipment for night operations, (see "Once Upon A Flashlight," Jan '60, DIGEST) plus usual radio communications.

In future combat operations we will need an IFR capability. The day of picking any old field for operations, at least a division base airfield, is fast disappearing. Our considerations must now include not only VFR but all the details of operation from that field under all conditions of day, night, and IFR.

In the combat zone we will camouflage our airfield. We cannot afford to make an obstacle-free approach path to the field. Voice communications must be kept to a minimum to keep the enemy from fixing our airfield location. For these same reasons, elaborate lighting systems will not be available. The homing beacon should be emplaced away from the airfield also; yet, it must be located so that our own people can find the field under IFR conditions.

If we are going to have this IFR capability, we must be able and willing to operate it. Training must commence now so that the operation will work smoothly under combat conditions. Once we move into the field, it will be too late to discover our equipment or personnel is inoperative.

We have well trained operations personnel in our present units, as attested by the low number of violations filed against them by Military Flight Service and the FAA. This record is based on civil type air operations, and this is only right, because that is where the

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Captain Johnson is with the Instrument Division of the Dept of Advanced Fixed Wing Training. He is dual rated and instrument qualified, with approximately 2,500 flight hours.

main emphasis on their training has been centered.

The basic fundamentals of the Air Traffic Regulating Plan follow closely the procedures developed by ATC and the FAA after many years experience in controlling air traffic. Diligent use of this plan can make flying a little safer for us in the combat area.

The entire combat zone IFR system depends on timely and accurate information concerning routes and letdowns, starting at the division base airfield. A unit selects its field, emplaces the equipment, flight checks the facilities, and then disseminates the information to other using units in the system. Higher headquarters will designate the routes between the units.

It will be evident from the beginning that such a system cannot be operated without an excellent communications system. The air-ground link will be provided by the aircraft radios and the ground radios issued to the aviation units.

Ground communications seem to present the biggest problem to overcome. Telephone circuits must be made available as a primary means of ground communications, backed up by teletypewriters. We might even need electronic data computing machines to keep us abreast of the mach 1—speeds of present day missiles and aircraft that will be operating in the area.

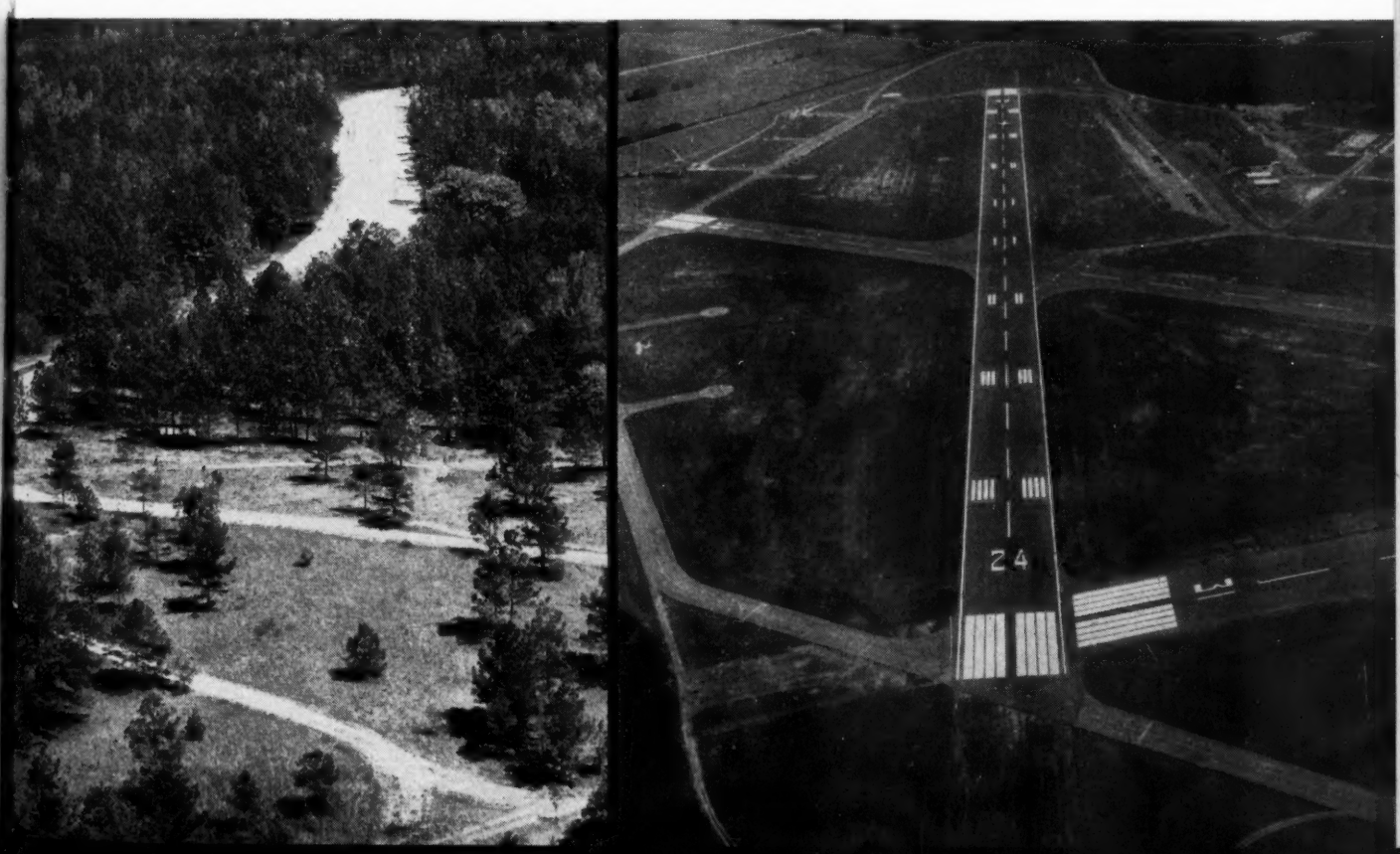
ADP requirements for rapid transfer of information between Flight Operation Centers and Air Defense Command Posts is being studied in an effort to reduce manual handling of flight information.

The placement of aids to navigation in any commander's area will be influenced by his attitude toward and his need for aircraft support. However, operation of present low frequency aids at their lowest outputs should be considered if missions can be accomplished. Another point of view is that one more radiating device will mean little or nothing to the average situation.

The operations section must maintain an accurate and up-to-date file on the flight routes and letdown procedures. Yesterday's flight information is not necessarily valid today. A mistake in transmitting, compiling, and recording information, or an error in flying the route or making the letdown can easily be a fatal one.

How many operations sections know how to emplace correctly and operate the homing beacon? How many can make up a correct and usable approach plate or plates and select a proper air corridor for use in IFR conditions? How many instrument rated pilots or instrument examiners can accurately flight check and rec-

There is a difference



ommend headings, altitudes, missed approach procedures to operate the home field under IFR? Those with this ability are the lucky ones because this particular course of instruction is not taught in all of our Aviation courses. I received all of my information on the subject at the Aviation Staff Officers Course (See "ASOC," April '60, DIGEST). The details of IFR operation in combat did not strike me as any big problem before.

VFR and IFR capability is not necessarily compatible in one field. We have all been into short fields during the day when we would not risk that same field at night or make an IFR approach there.

I think some difference exists in making an IFR approach to a place like Cairns AAF and making a minimum ceiling and visibility approach to a strip similar to Road Strip 16 or Strip 114 at Fort Rucker. The basic technique will remain the same. You will be coming in a little slower, a little steeper, and a little lower to a strip not as easily identified. The mental hazard will probably be much greater when breaking out at 300 feet over trees than when breaking out at 400 feet with high intensity lights pointing you to the centerline of the runway.

The only way it is going to get any easier is through practice and then more practice. In the best interests of training, the altitude and visibility minimums will have to be lowered during this training. I feel that more emphasis should be placed on simulated combat zone instrument techniques. This training should stress use of TOE equipment which permits ADF and GCA approaches to a short, unprepared strip and the homing capabilities of the ARC-44 homer.

The use of the ARC-44 radio for homing is presently being taught by the Department of Tactics at Fort Rucker. Each student is required to perform a minimum of 3 homing problems during the course of instruction, one of them at night.

Another item of equipment under development is the TRN-9 marker beacon. This is a small item of equipment of one cubic foot dimension and weighing 50 pounds. It has a controllable signal pattern and can be used as a "Z" marker, outer marker, or middle marker. The biggest drawback to this item is the 110-115 volt, 150 watt input. The generators of this capacity are rather noisy and require no little amount of maintenance.

The number of IFR days in any particular area of the world is generally very small over the period of a year. Aviation FMs, TMs, Circulars, and other publications say we have an IFR capability. We must all strive to maintain and improve our combat IFR system. Diligent use of this system can make flying a little safer for us in the combat area.

In this article I have covered, very briefly, some of the problems we will encounter in operating a combat IFR system. I would like very much to see or read some of the solutions that have been advanced to solve these problems.

(EDITOR'S NOTE: FM 1-( ) ARMY AVIATION AIR TRAFFIC OPERATIONS-TACTICAL has been prepared by the U. S. Army Aviation School. It is presently at USCONARC for review.)

REMINDER

"Recently we had a mechanic report that when removing an earplug he 'felt a loud plop' accompanied by intense pain. Examination showed a perforated eardrum and an infection of the ear. The mechanic states that it was his custom to wet the plugs with saliva before inserting them. He had experienced the popping sound when removing them before, but had not had any aftereffects.

"The Medical Department advises that wetting earplugs or the presence of an excessive amount of wax in an ear can cause such a tight fit that sudden removal can cause a vacuum, with results similar to those described.

"Slow and gentle removal of the plug from the ear canal at all times is recommended. Easy does it."

—AVIATION MECHANICS BULLETIN

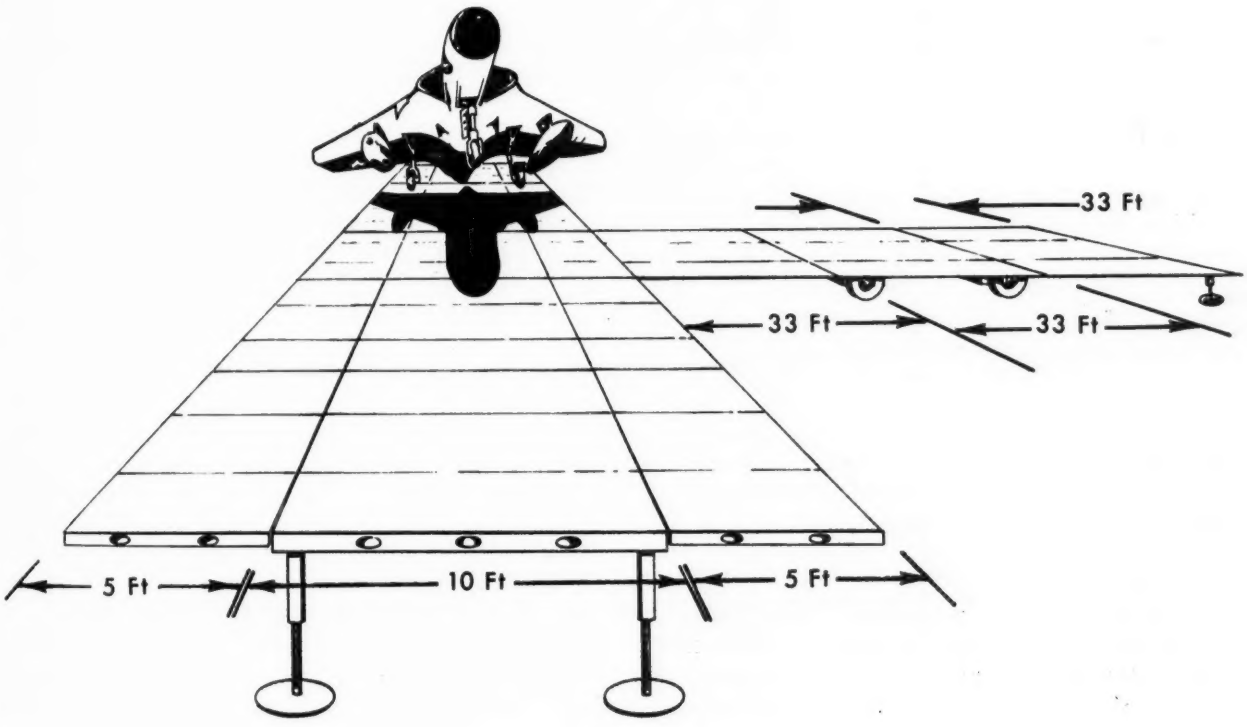
Field Army Mobile Airstrip

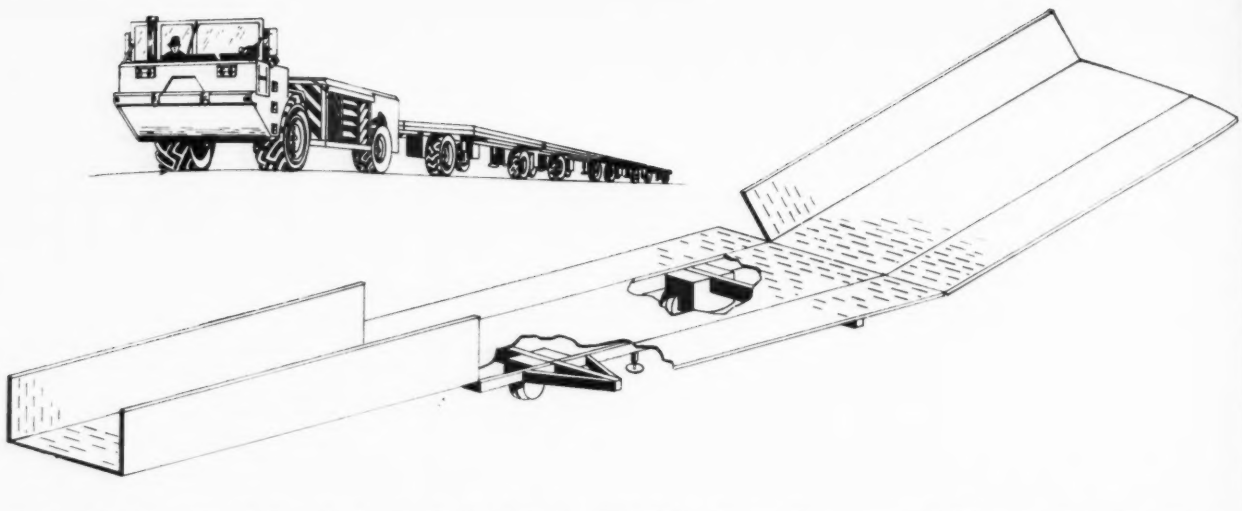
Major Eugene R. Lucas, Arty

THE FLIGHT WAS MADE deep into enemy territory. Twice, missiles with active homing devices came near the plane, missing it by the thickness of the camouflage paint, which the engineers insisted would conceal the aircraft from ground detection. The target area was teeming with activity, protected by surface-to-air missiles mounted on vehicles, small cal. MGs, and other weapons that seemed to extend their barrels up to my fuselage.

I had been on the deck most of the flight to escape radar detection, but now I had to get some altitude to photograph an area suspected by G2 to be an active and troublesome ballistic missile launching site. I tuned my electronic countermeasure set to fully automatic and began my run on the target. No sooner had I taken my pictures (by both conventional photographic and electromagnetic means) than tumult broke loose, or so it seemed anyway. Several bursts appeared above

Major Lucas is Chief, Doctrine Division, Combat Developments Office. He is a Senior Army Aviator with approximately 3,600 flight hours in fixed and rotary wing aircraft and is instrument qualified.





me and to my left that I thought surely would cause me trouble. But somehow my plane remained in one piece. Although I had kicked rudder and spilled aileron to head the aircraft straight for the ground, I couldn't seem to get down fast enough.

Things quieted down somewhat after I got down into the nap of the earth. Now I could concentrate on getting back to my unit. The 5th Aerial Combat Surveillance Co. said they would wait for me to return before they displaced the airstrip. I hoped so as not too much daylight remained, and I wasn't too keen on landing on this new mobile airstrip idea, and in strange surroundings to boot. Come to think of it, why did I ever agree to try out this mobile airstrip idea anyway? I guess the old man did it for me, but I wish I had put up a more convincing argument against it. Oh, well! Good night, why am I worrying about that? I've still got another 150 miles to go to reach our lines, and another 20 to reach my unit.

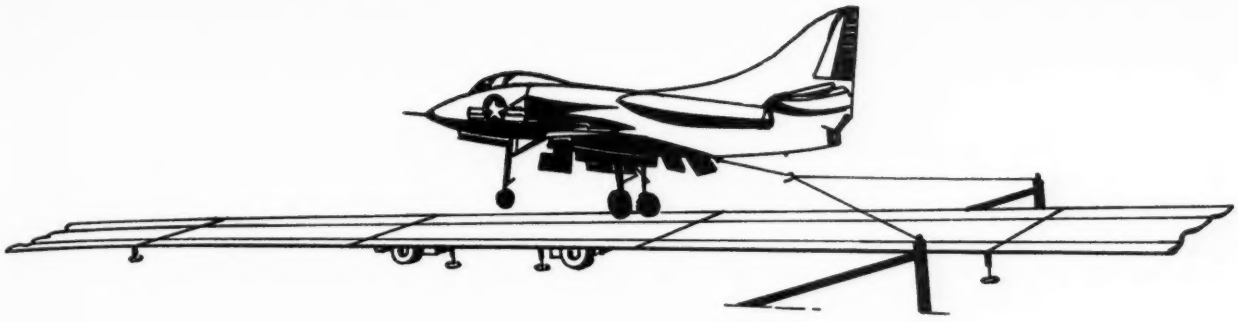
It's pretty smooth down here in the nap. At my 100 knots (IAS) it will take me 1 hour and 30 min. to reach FEBA. If I climb up to 400 feet above the trees I will be able to increase my speed to 600 knots. This will enable me to return to our lines in about 15 minutes. But I don't know—at that altitude these hoods with their redeye type weapons will pick me off like a clay pigeon. If I remain down here in the nap I'll stand a good chance of getting back in one piece. But on the other hand I won't make very good time. Well, let's see, if I climb another 20 feet above the trees, I can increase my speed another 60 knots and still be close enough to the trees to be relatively safe from attack. Not bad, that will give me about 160 knots groundspeed. At this rate I should reach our lines in comparative safety in about, in about . . . wait until I get around these high trees . . . now let me see, 160 knots per hour and from checkpoint 19 dead ahead of me, I must have about 142 nautical miles to go. That would be . . . oh, 53 minutes, I guess.

I have enough fuel for 1 hour and 30 minutes. That leaves me about 30 minutes to mill around in case my homer and radio gear are damaged or fail to function or I get lost. Get lost —me? How would I ever live it down? Can't let that happen.

After contacting the flight control center (FCC) of one of the forward area divisions with my automatic digital communicator, I was cleared inbound. The FCC transmitted my position to FOC who advised the 5th Aerial Combat Surveillance Co. terminal control and I was vectored to my unit. They had displaced due to heavy ballistic missile attacks in the area.

Now I am in a tough spot. I wonder whether the airstrip is completely operational. Control said that the strip had displaced shortly after I had departed. That was 2½ hours ago. According to the map, they only moved 20 miles laterally and had good roads all the way. The mobile airstrip is capable of being readied for movement in 20 minutes and emplaced in a fairly decent area with a well trained crew in about 30 minutes. The tractors can travel on the roads in this area at about 25 mph, so the elapsed time for all this should not exceed an hour and 45 minutes — time enough.

This is fantastic, and simple: an airstrip that provides an all-weather surface in any terrain.



All the developers have really done is line up in tandem a series of trailers with beds strong enough to withstand continued aircraft operations. Extensions provide extra width. An arresting cable, similar to that used by the U. S. Navy, is attached at the approach end to catch landing aircraft. On the other end you almost always find an Army Aviation Transportation Maintenance and Supply Unit. You don't suppose — no, they wouldn't be located there for that reason. I don't see any at the present, though.

Well, here goes, the mobile terminal control unit has cleared me number one for landing. I set up my approach as I make my turn from base to final; and as I look at the short strip ahead, it's only 800 feet long and 20 feet wide, I wonder. This aircraft I'm flying is really in the high performance class and is not as forgiving as the old Cub, Bird Dog, or Mohawk. My final approach is made half by the seat of my pants and half by the glide slope meter provided for such occasions. I've got to chop power no higher than 3 feet above the third dot on the strip, just before I reach the large crossbar. By doing this I'm assured of being caught by the arresting cable and hauled to an abrupt stop.

All goes well. After being unhooked, Sergeant Jones waves me toward the parking area. After shutting down, Sergeant Jones informs me that I had lost almost all my fuel from several punctures and could not possibly have made it much farther to the rear. Lucky for me, as there are no airfields within 75 miles in that direction capable of handling this type aircraft. As I fill out my 781-2, I suddenly realize what a wonderful airstrip this really is!

Continued from page 5

tion of the Army Aviation Advanced Course, its graduates should be **detailed to Army Aviation.** No longer should they be expected to maintain a singular branch proficiency; rather, they would be capable of serving in multibranch roles as a division aviation officer, an aviation company or battalion commander, or a surveillance platoon pilot.

This would not lessen the need nor the supply of OFWAC graduates who would serve in branch material assignments as branch proficient officers. It would, however, eliminate the great expense the Army now incurs in providing the current full "C" phase for all OFWAC students.

In essence, this advanced course—and the new policies suggested—would **solve** the enigma of instrument and branch proficiencies, **provide** Army Aviators qualified to conduct that program, **avoid** the stigma and disadvantages of an Aviation Branch, **provide** an orderly method of managing the careers of all Army Aviators, **eliminate** fruitless t r a i n i n g , **eliminate** the schism between the Transportation Corps and the combat arms—and **save** money. It could be a PANACEA.

Do you agree with the author? Comments pro or con are welcomed on this article. Address comments to the Editor.

THE
U. S. ARMY
BOARD
FOR
AVIATION
ACCIDENT RESEARCH

TWX

L-20A ENGINE was heard running rough and craft started 180° turn, dived into canal during turn. Pilot and 4 passengers killed. One passenger missing. Aircraft destroyed.

H-13G ENGINE FAILED during hovering flight. Aircraft landed with no damage. No. 3 cylinder ruptured at base; piston disintegrated. Cause undetermined pending analysis.

L-19A TIRE BLEW during landing. Aircraft destroyed. No injuries. Suspect deteriorated inner tube.

H-21C TAXIED beside another parked H-21. Forward rotor blades of taxiing aircraft struck aft rotor blades of parked aircaft. Both sets of rotor blades destroyed.

L-19A ENGINE FAILED during flight. Landing gear washed ut during forced landing. Two pistons failed and broke through crank case. Cause undetermined pending analysis.

H-21C CONTROL LOST during test flight after maintenance. Aircraft settled in nose high, causing major damage to landing gear and fuselage. No injuries. Aft control link (P/N 22R3068-4) had been removed and not replaced.

U-1A OIL PRESSURE DROPPED to zero while flying at 8,000 feet. Engine seized. Aircraft landed with no damage. No significant rise in oil or cylinder head temperature prior to oil pressure loss. Tube assembly (P/N C3E3-11, FSN 15160-589-0997, oil delivery line from firewall to top of sump) failed under sleeve.

H-21C AFT ROTOR BLADE struck wire during landing approach to confined area. Incident damage.

L-20A VEERED into direct 20-knot crosswind during takeoff. Major damage to left wing, left gear and stabilizer. No injuries.

H-34A FLARED too steeply during power recovery from practice autorotation. Tail wheel struck ground. Tail wheel broken; tire blown; skin damage to under side of tail pylon; and ADF antenna broken.

H-13G ENGINE FAILED at approximately 275 feet MSL over forest area. Aircraft autorotated into trees. Major damage. No injuries. Suspect fuel starvation.

H-13H LOST AIRSPEED and rotor rpm following downwind turn at low altitude. Aircraft crashed. Passenger suffered leg fracture, contusions and abrasions; pilot received minor contusions and abrasions. Aircraft destroyed.

H-19D ENGINE LOST POWER. Aircraft autorotated to forced landing with no damage. Suspect impeller failure.

H-34C ENGINE FAILED shortly after switching on center transfer pump. Aircraft landed with no damage. Excess water found in fuel and fuel mixture control linkage improperly rigged.

H-13E ENGINE FAILED in flight. Aircraft completed forced landing with no damage. Hose from carburetor diffuser box to intake manifold became disconnected at diffuser box.

xpts from june and july

H-21C TOUCHED DOWN in tail-low attitude during practice autorotation. Aft keel longeron installation and fiberglas of lower tail faring damaged.

H-34A HYDRAULIC leak noted in flight. Aircraft completed normal landing. Ruptured hydraulic line found in primary servo system.

H-34C CLAMSHELL DOOR opened in flight. Clamshell door and radio antenna damaged.

H-21C AFT ROTOR BLADES struck small tree in confined area. Incident damage to rotor blades.

H-23C ENGINE FAILED to respond during attempted power recovery from practice autorotation. Aircraft landed hard. Main rotor blades flexed down and severed tail boom. Suspect engine failure.

YAC-1 LANDED HARD short of runway. Fuselage buckled and twisted; left wing buckled. No injuries.

H-34C ENGINE RPM increased with throttle closed and pitch decrease during confined area approach. Aircraft was autorotated to road landing with no damage. Throttle box bolt (P/NS 1630-8026) missing.

L-19A STRUCK SMALL TREE, turned and crashed into field during simulated forced landing. Aircraft burned. Instructor pilot suffered minor head lacerations.

H-21C AFT ROTOR BLADES damaged during confined area approaches. Three-inch hole in each blade not found until after flight.

H-34C ENGINE FAILED at 500-foot altitude. Tailwheel fork bent during autorotation touchdown. Suspect fuel contamination.

U-1A TAILWHEEL struck culvert at approach end of runway during landing. Skin damage to fuselage and tailwheel hydraulic strut damaged.

L-19A STALLED AND SPUN IN during turn to base for landing on tactical strip. Pilot killed. Aircraft destroyed.

H-19C MADE TAIL-LOW power recovery from autorotation. Tail rotor blade tips struck ground. Incident damage.

H-13G CRASHED during simulated backwards abort from confined area takeoff. Instructor pilot killed. Degree of pilot's injuries: severe to unknown.

L-19E ENGINE ran rough and lost power in flight. Forced landing completed with no damage to the aircraft. Rough engine and power loss caused by malfunction (more than 200 rpm drop each) of magnetos.

L-19E GROUND-LOOPED to left during takeoff. Right wing buckled; right gear severed. No injuries.

L-19 WHEEL DROPPED in hole while taxiing. Incident damage to propeller.

L-19A WING STRUCK tree during approach to road strip landing. Incident damage to left wing.

H-13E COMPLETED forced landing with no damage after partial engine failure in flight. Fouled spark plugs found.

Continued from page 9

FATIGUE

"It is extremely difficult to evaluate the role of fatigue in aircraft accidents. The manifestations of fatigue are diffuse and frequently so insidious to the functioning of almost any body system as to be unrecognizable to the subject. Fatigue is characterized in all cases by decrements in skill, reduced functional reserves and acceptance of lowered performance standards. Subjectively, fatigue induces a sensation of tiredness and lassitude.

"Fatigue may be caused by a number of factors, both internal and external to the subject. Physical fatigue occurs as a result of excessive usage of body tissues and organs. This type of fatigue is rarely seen in aviation. Skill fatigue results from the prolonged application at a skilled task in the presence of exposure to stresses of many kinds and is most often seen in the operation of high performance aircraft, where multiple and persistent demands are made requiring constant attention from the recipient. Fatigue in these cases may be related to the performance of a single or very limited number of body functions, and its onset may be quite insidious. Finally, static fatigue is most often seen during long flights where the subject is restricted in movement, frequently placed in relatively cramped positions, and exposed to temperature extremes, noise, vibration, accelerations, and other environmental stresses.

"In evaluating fatigue, the subject's activities for the period preceding, as well as during, the actual flight should be reviewed. Poor personal habits, late hours, inadequate rest, domestic problems, anxieties, and irritations preceding a flight may easily cause fatigue during relatively short flight exposures. Noise and vibration are extremely important secondary contributants in helicopters, especially so since the subjects are exposed to acoustic and vibratory energy in the more annoying frequency ranges. Vibration of body organs and overstimulation of the inner ear are especially disturbing. Fatigue in pilots is especially hazardous in that it is most apt to occur during the landing phase of the flight—an extremely critical time, since his workload is the heaviest and most demanding of the entire flight. Prolonged flight time, increased number of landings and takeoffs, increased vigilance in low altitude flying, use of instruments, and formation flying all contribute heavily to fatigue. Preventive measures for avoidance of fatigue include appropriate aircraft design to eliminate extrinsic stimuli, proper duty cycling, development of good personal health habits, and careful monitoring of the aircrewmen by the flight safety officer and flight surgeon.

DISEASE

"Incapacitation resulting from disease processes, while not statistically important in accident causation, is being detected with increasing frequency now that more autopsies are being performed. **Of greatest concern are coronary heart attacks, which are occurring with sudden and catastrophic results in relatively young pilots.** Other disorders, such as rupture of congenital cerebral aneurysms, pneumothorax and convulsive seizures, have occurred during flight in presumably healthy subjects.

"Prevention requires more sophisticated techniques and procedures for detection or prediction of these conditions. Temporary incapacitation has been reported at fairly frequent intervals in aircrewmen, but because of its usual physiological causation, has seldom been detected in investigations of fatal accidents. One of the most common conditions is syncope, resulting from cardiac arrhythmias induced by the pulmonary stretch reflex or carotid sinus stimulation, head movements, recent illness, and painful stimuli.

ENVIRONMENTAL STRESS

"A number of environmental stress conditions have been incriminated as secondary contributing factors in aircraft accidents. These stresses may act singly or in combination to seriously reduce the pilot's capacity by adversely affecting his judgment, skill, or reaction time. Occasionally, the answer to the 'why' a pilot committed an unsafe act may be found within this category of conditions. Cabin contamination by smoke, fumes, or carbon monoxide [see CRASH SENSE] is most apt to occur in small aircraft with single, in-line engines, short exhaust stacks, unsealed cabins, and exhaust-fed cabin heaters. In most cases, cabin contaminants are present in concentrations well below the lethal level and produce mainly irritating effects. While annoying and disturbing

to the flight crew, they seldom cause incapacitation. There have, however, been several cases where accidents have been caused by contaminants such as carbon dioxide, gasoline vapors, and other narcotizing agents.

NOISE — VIBRATIONS

"Noise is not a major problem in small reciprocating engine aircraft; it is, however, tremendously important in helicopters. Internal noise levels in the cockpit and cabin of military helicopters, especially when flying with doors and windows open, are higher than that of any other service aircraft. Fortunately, the total exposure time is sufficiently short to avoid permanent damage of the acoustic nerve. Temporary deafness and tinnitus may occur, and many pilots have complained of interference in communication, after 30 to 60 minutes of noise exposure. The use of ear defenders or special sound-attenuating helmets will greatly relieve this situation.

"Much of the vibratory energy produced by the rotors, engine, and transmissions in helicopters is in the low frequency range and, consequently, extremely annoying to the recipients. These vibrations, when associated with buffeting and accelerations, will overstimulate the inner ear and sensitive body tissues, thus hastening the onset of fatigue and vertigo.

NUTRITION

"Poor nutrition has occasionally been listed as an accident cause factor. Great emphasis is being given to proper nutrition for aircrewmen, especially with reference to overeating, missing of meals, inadequate diet and poor mastication. The reasons for the emphasis on obesity are quite apparent. Flight stresses, especially those associated with high altitude exposure and aeroembolism, are more apt to involve the obese pilot. **As an interesting sidelight to this problem of weight control, some pilots have resorted to self-instituted dietary regimens and appetite-depressing medication in the hope of avoiding censure by the flight surgeon. In their zeal to control obesity, pilots may be creating an even more serious health problem.**

"Statistics reveal that a disproportionately high percentage of accidents occur two to four hours after ingestion of food and that, in a number of accidents, pilots have either missed a meal or have gone long periods of time without eating. Despite these observations, it has been extremely difficult to prove by laboratory tests that hypoglycemia is a major factor in accident causation. To the contrary, studies have indicated a marked constancy of blood sugar level, regardless of the extent of food intake over periods of several days. Perhaps more important than hypoglycemia is the discomfort resulting from missing a meal and breaking a well-established eating pattern. **It would appear that hypoglycemia, if combined with other stress-inducing factors such as mild hypoxia, hyperventilation, excessive heat or accelerative forces, may affect a pilot's stress tolerance.**

TEMPORARY ILLNESS

"Temporary illnesses such as colds, intestinal disturbances, and other related disorders do not constitute a major cause of accidents. Such conditions can, however, cause discomfort and distract a pilot's attention from his primary duties. Upper respiratory infections may result in aerotitis or aerosinusitis and, in addition to causing discomfort, can reduce a pilot's tolerance to vertigo and other allied stresses. **There are a number of recorded instances in which pilots attempting to blow their noses or clear their ears have suddenly experienced marked vertigo due to the sudden increase in middle ear pressure, and presumably, inner ear stimulation.**

"Intestinal disorders are the most common cause of incapacitation in airline pilots and occur in flight to almost every pilot sometime during his career. Inflammations of the intestinal tract due to dietary indiscretions, excessive drinking, or infectious disorders leave the tract extremely reactive to internal gas pressure changes. Severe cramps and diarrhea have occurred at altitudes as low as 5,000 to 8,000 feet. Peptic ulcers have, on very rare occasions, ruptured during flights below 10,000 feet.

"Attempting to fly before full recovery from an illness renders one susceptible to fatigue, vertigo, and hypoxia. **Perhaps even more important is the problem of the pilot, who, without consulting the flight surgeon, takes medication to treat his disorder.** Any of the commonly used drugs such as the antihistamines, antispasmodics, stimulants, sedatives, and antibiotics could adversely affect a pilot's performance. **Education, plus confidence in one's flight surgeon, should remove the necessity and desire for self-medication; however, many pilots still refuse to visit the flight surgeon when suffering from an illness for fear of being grounded.**

ALCOHOL

"Alcohol has definitely contributed to a number of aircraft accidents, including those involving small planes. Alcohol has a narcotizing action, and through its cerebral effects, reproduces the symptoms of altitude hypoxia with defective judgment, slowing of reaction time, poor discrimination, and visual disturbances. Unfortunately, pilots seldom realize the prolonged aftereffects of alcohol, especially upon the vestibular system. Education and self-control are obviously indicated.

HEAT

"Pilots in aircraft flying at relatively low altitudes and slow speeds may be subjected to intense heat. The ensuing fluid and mineral loss hastens fatigue and induces increased stress upon the circulatory system. When operating in northerly climates, pilots may be subject to intense cold if the cabin heating system is inadequate or defective. Slowing of reaction time and discomfort may result.

HYPOXIA

"Hypoxia is a major problem in high performance aircraft; however, it is rarely encountered at altitudes below 10,000 feet. Some deterioration in night vision is noted at altitudes as low as 5,000 feet. In aircraft flights above 10,000 feet, hypoxia will be encountered if exposure times are sufficiently long. Unconsciousness first occurs between 18,000 and 22,000 feet after an exposure of 10 to 15 minutes. **Some of the more serious manifestations of hypoxia, involving the judgment and skill of the pilot, may occur as low as 15,000 feet.** The early onset of fatigue is characteristic of low-grade hypoxia. Smoking, carbon monoxide, metabolic disorders, and physical activity may enhance the effects of altitude hypoxia. **Education in the effects of hypoxia and training in the use of oxygen equipment must be given pilots flying above 10,000 feet.** A proper respect for hypoxia should be instilled in all pilots prior to their first possible exposure.

STUDENT QUESTIONS

"Army officers attending the flight safety officers course at the University of Southern California are asked to contribute questions to the instructor in physiology indicating the areas of greatest concern to them. Since these officers are the ones most closely associated with operational aviation safety, it is interesting to note the medical areas of greatest interest to them. The majority of officers indicate a greater need for education concerning the effects and recognition of fatigue, and in some cases asked for on-the-spot tests to determine the presence of fatigue immediately before a flight.

"They indicated that fatigue is a much greater problem in actual operations than is apparent from a cursory examination of accident reports. Several officers admitted flying as much as 13 hours daily, frequently at low altitudes and in poor weather. Others indicated multiple daily flights of two to three hours each, with total monthly flight time in excess of 150 hours.

"Special reference was made to conditions surrounding field exercises and the combined effects of inadequate diet, poor housing, and long flight hours. Examples were cited of pilots who flew with less than four or five hours of rest in the previous 48 hours. In the majority of the cases, officers felt that they, rather than their flight surgeons, were in the best positions to detect fatigue among their pilots.

"Considerable interest was also expressed concerning the personal health of pilots with respect to heart disease, obesity, self-medication, and physical fitness. One officer cited a large number of coronary heart attacks among his personal friends which occurred within a short period of time. **In a few cases, criticism was leveled at the flight surgeon, indicating that contact with their doctors was limited to a yearly physical examination and an occasional lecture.**

"The officers recommended more thorough physical examinations with comprehensive, post-examination discussion of their health problems with the flight surgeon, identification of reasons for grounding after reporting illness, and the establishment of regulated physical training programs. It was the consensus that many pilots flew with physical disorders rather than seek medical help for the reasons previously given.

"Several pilots in supervisory and command positions requested more intensive physiological indoctrination, indicating that many Army Aviators, and especially noncommissioned flight personnel, were given no formalized physiological training. They indicated that information concerning vertigo, hypoxia, and vision was

most urgently needed. A surprisingly large number of pilots had made frequent flights above 10,000 feet, and some had used oxygen equipment. Almost all expressed concern regarding the effects of hypoxia should aircraft with higher capabilities be introduced into Army Aviation. A few wanted more information concerning the effects of temperature extremes. Finally, many asked questions concerning the effects of alcohol on pilot performance, especially when coupled with late hours and poor nutrition.

"It would appear on the basis of these questions that this indeed represents one of the most fertile areas for the application of aeromedical principles to accident prevention."

Aviation Psychology

"If man and machine are to achieve more in combination than either could alone, the best qualities of each must be used," said Dr. Neil D. Warren, Head, Department of Psychology, University of Southern California, and Lecturer, Aviation Safety Division, USC.

"The integrative function of the human component of the system is obviously highly complex. In addition to the perceptual and motor functions of the central nervous system, it serves for storage and memory, and for the decision-making aspect of behavior, commonly called judgment. Judgment is a matter of making choices among alternate actions. Adequacy of the decision depends on a variety of factors:

perception—identification and appraisal of the situation;

information—choice of pertinent facts from memory storage;

reasoning—ability to think clearly;

motivation — biological and social needs which influence decisions.

MOTIVATION

"Motivation is a uniquely human characteristic," said Dr. Warren. "No other component in the control loop derives satisfaction from flying, or suffers from fear and anxiety. **Even the best trained, most intelligent pilot cannot exert good judgment unless he is properly motivated and can handle the anxieties he will encounter.**

"Flying holds both positive and negative attractions for men." Dr. Warren explained how every aviator has experienced the feeling of exhilaration which comes from flying and also the unavoidable danger, discomfort and fear of flying from the same source. He quoted a surgeon: " 'The reality behind the stress which brings on anxiety associated with the risks of military aviation is the fact that one can be killed while flying.' " Dr. Warren defined these positive and negative attractions as an **approach-avoidance** conflict. "The strength of the conflict normally is reduced by effective pilots, who are able to de-emphasize its negative side. Nevertheless, it is an inescapable conflict in flying. **Every aviator has to come to his own terms with it.**

"Another dilemma encountered in aviation, and in other occupations as well, is the conflict between professional and personal motivation. The member of any profession knows that there are times when he must choose between the demands of his profession and his personal desires. He must choose between work and rest; between professional ethics and financial reward; between the course of action dictated by reason and the one that will enable him to achieve some immediate personal satisfaction.

"The aviator faces these major dilemmas and numerous others related to the accomplishment of his duties. The term **homeward-boundit is** describes only one of the many situations where motives can, sometimes fatally, modify judgment.

INADEQUATE MOTIVATION

"The answer to the question 'Why do men fly?' does not always lie entirely in the general satisfactions," said Dr. Warren. "Indeed, we can find almost as many answers to this question as there are fliers. Human motives are complicated in their origins and in their effects. Some are learned, some are produced by inherent physiological processes. Some are consciously experienced, others operate subconsciously. Some are temporary, others exert their effects throughout life. All are interrelated, first one and then another dominates behavior at any one time, depending upon the physiological and psychological deprivation of the moment, and the social and situational contexts in which the behavior is occuring."

According to Dr. Warren, an aviator may start his flying career with good motivation,

then gradually shift to an unhealthy pattern because of changing circumstances in his personal life. Still another aviator may have never had good motivation and be on the ragged edge of performance all during his flying career. The aviator who experiences a narrow escape from death may change his attitude toward flying. The young aviator who decides on a flying career because of its glamour and to impress his girl friend may lose all motivation when he finds flying to be hard work and loses his romantic illusions.

Explaining biological drives, Dr. Warren described how felt needs may motivate a person to activity, but do not always guide this activity into satisfactory responses.

LEARNED BEHAVIOR

"The newborn infant kicks and screams when hungry. These responses alone would not avert starvation. The hungry adult ordinarily does not walk into a supermarket, open cans, and satisfy his hunger on the spot. This response might satisfy his need, but it would be punished by society. People learn the need-satisfying responses that are socially permitted or approved."

BASIC CONFLICTS

Dr. Warren explained how the use of other terms help in understanding other unhealthy patterns of motivation and lead to ways in which individuals may be helped.

Approach-approach conflict: Here the individual is torn between two equally attractive, but mutually exclusive goals. Dr. Warren illustrated with a joke about a jackass that starved to death between two haystacks because he could not decide which one to go to first. He explained that the jackass was really not much more stupid than his human counterparts when faced with a similar conflict.

Avoidance-avoidance conflict: In this case, the victim is caught between "the devil and the deep blue sea." He faces two equally unattractive alternatives and often has little time to choose between them. He can avoid one but not both. An example is the aviator who experiences engine failure over doubtful terrain. Should he attempt a forced landing or bail out?

Double-approach avoidance conflict: According to Dr. Warren, this is where things really become complicated: "A person in this situation has to choose between two equally attractive goals to which are attached equally unpleasant consequences. Either way he jumps, he will experience both satisfaction and frustration. For example, a college student may be torn between making a good scholastic record and making the football team. If he chooses the former, he will lose the regard of his immediate associates, all of whom are football players. If he chooses the latter, he will lose the approval of his parents, who have professional aspirations for him.

"A situation similar to this sometimes develops in a pilot's military career. He may be offered an opportunity either for formal advancement or for remaining at his present military grade and going with a group to which he has become extremely attached. Whatever his decision is, he will lose something and gain something."

"Practically speaking," said Dr. Warren, "the consequences of unresolved conflicts are manifested in indefinite impairment of performance, and in subjective feelings that are extremely unpleasant. The latter, characterized as emotional misery, may lead to psychosomatic or mental illness.

"Impairment of performance often takes the form of vacillation, apparent stupidity, rigidity and fixation. These symptoms are characteristic of stress, whether produced by conflict or by some other source; hence, it cannot be concluded that a person manifesting them always is suffering from an unresolved conflict. They are observable in conflict situations, however, and **there is no doubt that psychological conflicts and flying are a poor mixture.** If the conflict is not related to flying, its existence will detract from the pilot's ability to attend to his job. If it arises from some aspect of flying, e.g., abort or continue the takeoff run, failure to resolve it promptly can be as dangerous as choosing the wrong alternative."

MOTIVATION AND SAFETY

Dr. Warren concluded his talk by describing the flight surgeon's responsibility for dealing with individual cases in which flying proficiency has been judged to be too low due to such problems. "He (the flight surgeon) has the responsibility for the mental health of his group, insofar as he can contribute to it.

"He should know the aviators and their problems. He should know the sources of stress to which they are exposed, whether the stresses

are associated with flying, or are related to military matters, or arise from personal, family, or ethical conflicts. **The physician can contribute immeasurably to the success of the pilot's mission by helping him achieve mental, as well as physical, well-being. What's more, he will accomplish the physician's traditional objective: saving lives."**

Human Tolerance to G Forces in Aircraft Accidents

Colonel John P. Stapp, Air Force flight surgeon, and Chief, Aerospace Medical Laboratory, Wright Air Development Center, used a series of slides and film strips to describe how he pioneered in the basic research to determine human tolerance to aircraft crash impact forces.

Colonel Stapp is famed for his volunteer rocket sled rides at Holloman Air Development Center. In 1954, riding a 2,000 lb sled, he reached a speed of 632 mph in 2,800 feet and in 5 seconds. The sled decelerated with a force of 35 g's and a wind pressure of more than 2 tons.

Aviation Crash Injury Research

Mr. Gerald M. Bruggink, Aviation Crash Injury Research, a division of Flight Safety Foundation, Inc., described the objectives of his organization and explained the ways in which Army medical officers can contribute to crash injury research.

According to Mr. Bruggink, a new prospect in aviation safety opens when aircraft accidents, involving casualties, are approached with this question: "Were the injuries an inevitable result of the circumstances or could they be attributed to controllable factors, such as lack of crashworthiness, inadequate occupant tie-down, or an injurious environment?"

AvCIR statistics indicate that approximately one-third of the persons fatally injured in general aviation accidents die in structural surroundings that are damaged only to a minor degree, while about two-thirds of the dangerously injured persons are injured in relatively undamaged environments. In an effective accident prevention program, injury prevention forms a logical counterpart to accident prevention.

ENERGY ABSORPTION

"Since crash force is inversely proportional to stopping distance," said Mr. Bruggink, "the magnitude of the crash loads at any location in the aircraft varies with the distance from the point of impact and the reaction of the intervening structure. Generally, the greater the distance from the impact point, the less the transmitted crash loads. This can be explained as follows: Structure which is not completely rigid, and on the other hand, not too fragile, can absorb a certain amount of crash energy by progressively collapsing. This effectively increases the stopping distance for the object behind this structure, as shown in the following example. A helicopter strikes the ground in level attitude with a vertical speed of 30 mph. Assuming a rigid structure and a ground scar of one foot deep (stopping distance), the deceleration of the occupants would be 30 g. If the structure underneath the occupants would progressively collapse for a distance of only one foot, the stopping distance would be doubled and the g load on the occupants reduced to half its former value.

INTERPRETATION OF WRECKAGE

"The scene of an accident and the condition of the wreckage can make a very misleading impression, because a wreckage is nothing but the static evidence of a dynamic occurrence. Aircraft structure always has some elastic properties, and its dimensions during the principal impact may differ considerably from those we find after impact. Also, the attitude of the aircraft, as it comes to rest, may be completely different from its attitude at the principal impact. Since the peak deceleration is directly or indirectly responsible for the most serious damage and injuries, attempts to correlate injuries with causative agents could be based upon the direction of the main crash force at principal

impact. This can often be determined by closely examining the wreckage, since the main crash force generally leaves permanent indications in the form of structural deformation or collapse.

"When most of the crash energy is absorbed by the nonoccupiable area (wings, landing gear, etc.) the cockpit/cabin area may be left remarkably intact, although the overall appearance of the wreckage would not suggest it. A cartwheel accident is a typical example of the protective action of energy absorbing structure."

Mr. Bruggink continued by describing human tolerance to crash forces, elaborating on the direction of g forces and various tie-down methods to restrain the body. "AvCIR studies list the frequency of injuries in certain body areas in the following order: (1) head, (2) lower extremities, (3) upper extremities, (4) neck and upper torso, (5) lower torso, and (6) spine. This pattern definitely indicates a peripheral trend, i.e., the areas farthest away from the seat belt region are the most frequently injured. The obvious remedy for this situation is more restraint of these exposed body areas, such as the use of a good shoulder harness."

Mr. Bruggink concluded his talk by saying: "As our knowledge in the field expands, we become increasingly aware of the need for accurate and complete medical data from those involved in accident investigation. These data are the beginning of the road which, eventually, will lead to the incorporation of maximum practicable crash protection in all aircraft."

Army Aviation Medicine

Lt Col Richard B. Austin, III, Chief, Aviation Branch, Medical Plans and Operations Division, Office of The Surgeon General, described aviation medicine as a relatively new addition to the list of Army medical specialties. According to Colonel Austin, there are now 54 medical officers engaged in the practice of aviation medicine and there is a current world-wide Army requirement for 70. **He said that this requirement will in all probability increase with the growth of Army Aviation in the future.**

Colonel Austin expressed the hope that a new residency program will attract a significant number of young medical officers into the career field of aviation medicine. This program, scheduled to begin in the first quarter of FY 1961, includes:

1. Attendance at the primary course in aviation medicine at either the USAF or U. S. Navy School of Aviation Medicine, followed by the practice of aviation medicine for at least one year and a minimum of 100 hours of flight time in Army aircraft.
2. One year of training in preventive medicine at a civilian school of public health.
3. One year advanced course in aviation medicine at either the Air Force or Navy School of Aviation Medicine.
4. One year of residency in aviation medicine at Air Force or Navy schools or hospitals.

To be eligible for examination or for certification, the flight surgeon must also have two years of supervised practice, teaching, or research in aviation medicine.

Air Force Accident Experience

Major Samuel F. Neely, Air Force flight surgeon, Aeromedical Division, Directorate of Flight and Missile Safety Research, listed the physiological hazards of flying which appeared with increased aircraft performance. These include lack of available oxygen, or hypoxia, direct low barometric pressure effects such as bends, chokes, and barotitis, angular acceleration effects which can cause blackout or redout and interruption and confusion of the pilot's orientation sense when he is flying blind by use of aircraft instruments and radio signals.

According to Major Neely, the number of accidents caused by hypoxia has declined steadily over the years until the occurrence of unexplained loss of control has become very rare. Flight surgeons contributed to this success by participation in the development and modification of a double system based primarily on a pressurized cockpit backed up by a supplemental oxygen supply system; by indoctrination of crew-members in the consequences of hypoxia and how to prevent it, during both pressure chamber training and at flying safety meetings; and by continually monitoring the actual use of the system in the field.

Major Neely described psychological hazards as abnormal reactions, flying aptitudes and be-

havioral reactions. "The hazard of behavioral reactions," said Major Neely, "is actually the most important, and is the one which still presents the greatest challenge, not only to flight surgeons, but to command supervisors and, finally, to each individual himself."

Navy Accident Causes

Captain E. M. Wurzell, Naval flight surgeon and former Chief, Aeromedical Division, Naval Aviation Safety Center, reported findings of 728 Navy aircraft accident investigations. According to Captain Wurzell, faulty attention, forgetfulness, and poor judgment caused 207 of these accidents. None of the accidents were attributable to physical incapacitation of pilots in flight, although it was suspected as a factor in 4 of the accidents.

Captain Wurzell felt diet to be "pretty much" overplayed in accident causes. Fatigue was not established as a causative either, he said, but it was suspected in 25 accidents.

Captain Wurzell gave the diagnosis of aviators on days for which they are not suited to fly as a major task facing aviation medicine and one of the most promising tools for accident prevention.

Brother's Keeper

Captain Phillip B. Phillips, Naval flight surgeon and Chief, Neuropsychiatry, Naval School of Aviation Medicine, began his talk with a Biblical quotation: "Am I my brother's keeper?" Captain Phillips explained that when a flight surgeon asks this question, the answer is an emphatic YES. He said that aviators and flight surgeons must establish the closest rapport, where privileged information can be exchanged, if the flight surgeon is to reach his maximum effectiveness. The flight surgeon must be intimately acquainted with the aviators under his care. Not only should he be thoroughly familiar with every facet of their flying duties, but he must know their families and those socio-economic factors which may adversely affect flying ability. This relationship must be maintained on a day-to-day basis for the flight surgeon to recognize any physical change or stressful situation which might affect flying performance.

Early Detection of Heart Disease

Capt Ashton Graybiel, Navy flight surgeon and Director of Medical Research, Naval School of Aviation Medicine, spoke on the obvious limitations of electrocardiographic detection of some incipient cardiac abnormalities. He explained that work EKGs will sometimes isolate subclinical cardiac abnormalities and reviewed several cases of young pilots in which this was accomplished. Captain Graybiel said that ballistocardiography shows promise for the early detection of cardiac abnormalities.

Pilot Selection

"Ever since World War II," said Dr. J. R. Berkshire, of the Psychology Laboratory, Naval School of Aviation Medicine, "psychologists have been engaged in constructing and validating literally hundreds of tests to predict success or failure in all of the military specialties of all of the services—but on none of these has so much effort been expended as on the selection of aviators. **And this is perfectly reasonable, since the cost of training pilots is so high that the smallest improvement in the quality of the men selected for training can result in savings of millions of dollars; and also because a single mistake in selection always has the potential of costing many lives and much materiel."**

Dr. Berkshire explained the development of psychological testing in the Air Force and Navy during and following World War II. He described a controlled sampling in this manner: "Having identified a sample of men whom we probably should not have graduated, and a much larger sample who were perfectly satisfactory in the fleet, it is then possible to come back and look over the training records of these men to find places in training where we could

have set minimum standards that would have reduced the number of unsatisfactory men who reached the fleet.

"We found the first such cutting point in pre-solo flight training, the man's first 10 dual hops in a T-34 aircraft. Here, we found that of the lowest 7 percent of the men in terms of their pre-solo flight grade, one-half became failures later in training. Of those who graduated, half were unsatisfactory in the fleet. This meant that when any man got a pre-solo grade in the bottom 7 percent, the odds were three to one that he would not become a satisfactory pilot.

"This was a brand new kind of finding in the aviation training business, so we decided we'd better look into it a little further. We made a study of the comparative accident records of this lowest 7 percent in pre-solo as compared with men whose grades were higher. **And we found that 1 in 9 had pilot-caused accidents in training, as compared with 1 in 23 for students with higher grades. In the fleet their accident rate was twice normal, and their fatality rate was three times normal."**

Dr. Berkshire described how pretraining flights helped to identify poor risks for aviation training. He cautioned that the concept of pilot selection should not be restricted to a one-shot affair conducted prior to entry into service. He emphasized that it is only after real contact with military life and with trying to learn to fly that it becomes possible to get realistic measures of candidates' attitudes and motivations. It is far better to continue the selective process all through training, setting new minimums and establishing new procedures that will eliminate unsatisfactory pilots earlier. "This then," said Dr. Berkshire, "is the concept of selection in depth, which will make drastic savings in training costs and real improvements in the quality of our end product."

Visual Requirements

Capt J. L. Fuelling, Navy flight surgeon, and Chief, Ophthalmology, Naval School of Aviation Medicine, told of the need for excellent vision on the part of military aviators: "A pilot needs excellent distant vision for locating his plane in space, for spotting other planes and targets, and for proper identification of signal lights. A faulty interpretation of a colored signal may end in disaster for him or other persons on the ground. Good depth perception is necessary during takeoffs and landings and when doing formation and precision flying, especially at low altitudes. The modern plane has a complexity of instruments and proper near vision is essential.

"Aviators are 'eye conscious' and worry about minor eye conditions. Their extreme concern raises questions concerning pathological conditions, exercises, glasses, etc. A flight surgeon must have a fundamental knowledge of ophthalmological problems."

Civil Aviation

Maj Wayne R. Otto, Army flight surgeon, and Chief, Rules and Procedures Branch, Bureau of Aviation Medicine, Federal Aviation Agency described advances in the aeromedical aspects of civil aviation: "One method of increasing the safety in air commerce is that of better pilot selection to keep substandard personnel out of the air. A solution to this problem is to have as examiners those persons with an aviation medicine background. This has been the practice of the military for years but will start in civil aviation on June 15, 1960.

"Another solution is to set down definite standards based on past experience and/or medical knowledge. These standards must be high enough to eliminate the unsafe, but low enough to allow maximum participation in aviation without adversely affecting flying safety. As conditions change, the pattern may vary, but the underlying philosophy will not. During the past 18 months, we have endeavored to take a realistic but practical look at our medical standards. As a result of this consideration, we have altered our regulations to disqualify those with diabetes mellitus requiring hypoglycemic drugs, those with substantial history of coronary heart disease, and certain diseases of the nervous system.

"Concerning this latter category, the Agency, in the past year, has ruled that a history or clinical diagnosis of the following will be disqualifying: (1) A character or behavior disorder which is sufficiently severe to have repeatedly manifested itself by overt acts, (2) a

psychotic disorder, (3) chronic alcoholism, (4) drug addiction, (5) epilepsy, or (6) a disturbance of consciousness without satisfactory medical explanation of the cause. After several years of experience, along with that of the military, this change was deemed necessary in the interests of flying safety."

Maj Otto explained that a major difficulty for the FAA lies in the fact that there are some 700,000 certificated airmen in the country, making it impossible to police this vast group to ensure compliance with all rules and regulations.

"Probably the greatest factor in the advancement of safety," said Major Otto, is education of the public. If the public were made aware of the many facets which make for safety, many of our rules would not be needed. For example, the use of drugs and alcohol would be much better controlled by pilots themselves than by regulations."

Helicopter Noise

Maj Charles A. Berry, U. S. Air Force flight surgeon, Office of The Surgeon General, described the similarity of noise problems in helicopters common to both the Air Force and Army. Major Berry emphasized that noise problems are not limited to flight personnel, but also affect ground crews, sometimes to an even greater extent, due to more exposure. He strongly recommended that all flight surgeons urge aircrew and ground personnel to use ear defenders to prevent temporary and permanent hearing losses.

An article by Major Berry and Major Herbert K. Eastwood entitled **Helicopter Problems: Noise, Cockpit Contamination and Disorientation** was published in the March 1960 issue of **AEROSPACE MEDICINE.**

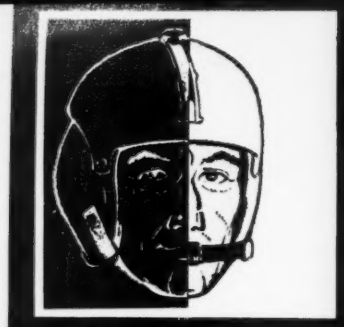
Pathology

Col Frank Townsend, Air Force flight surgeon, and Director, Armed Forces Institute of Pathology, described a prime function of pathology, in aircraft accident investigation as seeking cause factors in undetermined accidents. He gave an interesting example in which the finding of mucous membrane on the tail surface of a crashed aircraft helped investigators determine that the pilot escape ejection seat malfunctioned. Colonel Townsend emphasized that AFIP is available 24 hours a day for pathological assistance to all three services. He recommended that all major commands make use of the AFIP telephone service for information or assistance.

Human Factor Problems Not New

In a memorandum for the Chief of Staff, **dated 28 February 1914,** the Acting Chief Signal Officer described the first eleven Army aircraft accidents and concluded with this statement: "It is evident that the machines in which the accidents occurred were not old and the pilots were not novices. Before an officer is detailed on aviation duty, he is subjected to a searching physical examination, and as much information as practicable is obtained concerning his temperamental qualifications, and in case there is any doubt with respect to his physical, temperamental or professional qualifications, his application for this duty is disapproved. After having been detailed, he is sent to the Signal Corps Aviation School, where he receives theoretical and practical instruction in the art of flying. In my opinion, nearly every one of the above accidents was due to the pilots and not to the machines."

Almost half a century later, statistics show human factors as causatives in 779 of 956 Army aircraft accidents during the period 1 July 1957—18 April 1960. The difference between then and now is the vast amount of experience and knowledge available today, as evidenced by the papers delivered before the Army Aeromedical Symposium. To put this knowledge to full use, to continue research, and to stop an unacceptable drain on defense resources is the challenge facing the aircraft accident prevention program. The active role of flight surgeons is vital to success.



CRASH SENSE

PREPARED BY THE UNITED STATES ARMY BOARD FOR AVIATION ACCIDENT RESEARCH

HUMAN FACTORS

THOSE FORTUNATE enough to attend the first Army-wide Aeromedical Symposium in Pensacola heard authoritative talks about the most complicated component of aviation—**man.** To lend emphasis to what these leaders in the field of aviation medicine had to say, this issue of CRASH SENSE will describe several accidents and one near-accident with human cause factors.

ACCIDENT NO. 1

FATIGUE

During a winter field exercise, the pilot was assigned a Chickasaw mission at 1200 hours. He completed his preflight, entered the aircraft and started the engine. After warmup, he found the controls stiff and noted that the collective pitch would creep up when the cyclic was moved to the left. Once the collective pitch had risen, it was extremely hard to push down. The pilot shut the aircraft down and instructed the section chief and crew chief to preheat the servos with a Herman Nelson heater.

Some 4 hours later, the pilot returned to the aircraft, started the engine and engaged the rotor. He taxied out to the runway, picked the aircraft up to a hover approximately 3-5 feet above the ground. Suddenly, a loud thump was heard. The aircraft made a violent downward movement and struck the ground.

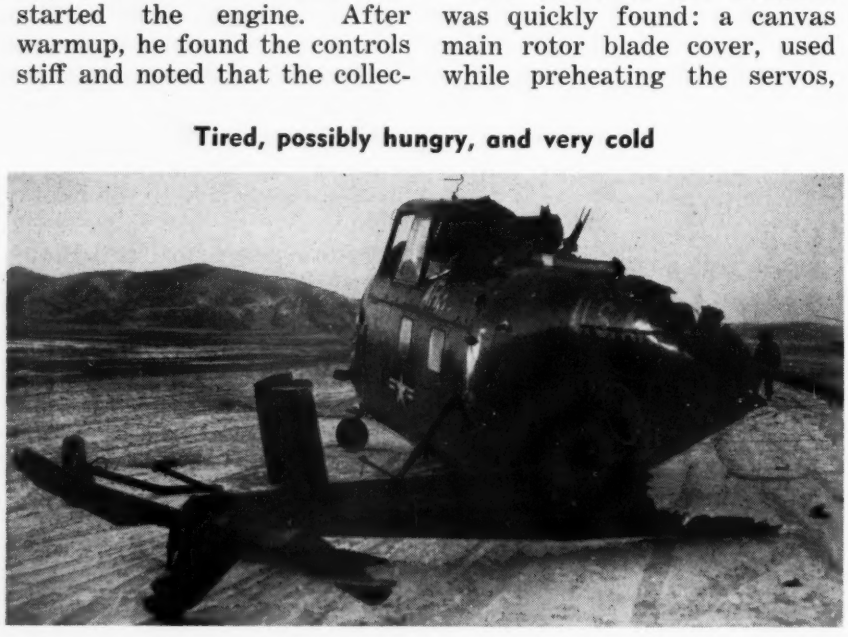
INVESTIGATION AND ANALYSIS

The cause of the accident was quickly found: a canvas main rotor blade cover, used while preheating the servos, had been folded and placed below the rotating star plate. This blade cover became entangled between the rotating and stationary star plates of the main rotor system. Pressure exerted by the entangled blade cover caused instantaneous failure of the rotating scissors and pitch change trunnion assembly of the yellow blade. All three main rotor blades changed from positive to negative angles of attack, causing the violent downward movement and crash of the aircraft. One blade flexed into and severed the tail cone. One blade sheared off at the main rotor head, setting up a severe unbalanced condition and tearing the transmission and main rotor system from its mount.

Simple case of inadequate preflight? You be the judge!

The accident occurred at 1615 hours, after the pilot had been awake since 0230 hours. He had slept 4-5 hours the night before and had flown approximately 4 hours on field maneuver type missions during the day of the accident. The accident report made no mention of his breakfast at 0230 hours, but stated that he had consumed only C rations once during the day. Temperature was 8° above zero and surface winds were 15 knots. According to information from the U. S. Medical Research Laboratory at Fort Knox, these conditions of temperature and wind result in an exposed skin temperature

Tired, possibly hungry, and very cold



of approximately 40° below zero.

Would you agree that these factors—a tired pilot, possibly hungry, doubtlessly very cold, anxious to complete the mission and secure for the day—could have a bearing on the "... failure of pilot to perform adequate preflight check"?

ACCIDENT NO. 2

FATIGUE

An Army Aviator, serving as battalion pilot during winter field exercises, was returning to an Army airfield at night in order to transport the night battalion CO to the CP field location early next morning. He noted a heavy haze and landed at a radar site to check for fog in a valley along his intended flightpath. He hovered the Sioux to the edge of a bluff, looked down into the valley and could clearly see the runway lights at his destination. The aviator took off directly toward the lights. A few seconds later, the forward momentum of the aircraft appeared to stop and there was a brilliant flash of light. The pilot instantly realized that he had struck high tension wires. The aircraft broke clear of the wires, traveled forward approximately 200 feet and settled to the ground, coming to rest on its right side.

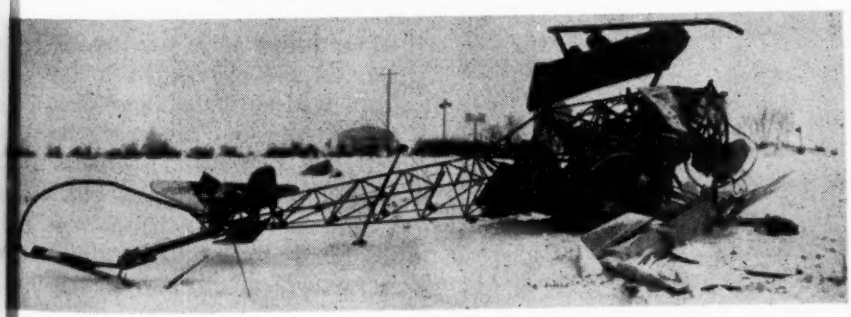
INVESTIGATION AND ANALYSIS

A complication to the solution of this accident was that the aviator knew about the wires and their location. He had landed at the same site in daylight a week earlier and carefully marked their position in his mind. In addition, he thought of the wires on the night of the accident as he hovered forward to look down the valley, and knew that a west climbout would be required to avoid them. Why did he then make a south climbout directly into the wires?

Checking further into this accident, we find that the assistant battalion pilot was ill and had not been able to participate in the field exercises. This increased the flying duties of the aviator involved in the accident. During the 5 days preceding the accident, he had flown a total of 23.2 hours, 5.2 hours of which were flown the day of the accident. The factor of fatigue becomes more evident when it is realized that the pilot was more susceptible because he had experienced several cold and restless nights under adverse field conditions.

The pilot admitted that when he was given the mission to return to his home airfield he became very much preoccupied with the desire to "get home" to a relatively cozy environment. This anxiety to get home to a warm bed and a good meal certainly contributed to a momentary lapse of memory when he saw the lights of his home airfield.

Warm bed and good meal in sight



ACCIDENT NO. 3

EMOTIONAL UPHEAVAL

An Army Aviator received a letter from his father-in-law's lawyer stating that he was initiating divorce proceedings at the request of the aviator's wife, who had gone home to mama. The aviator quickly lost his former exuberance; his attitude toward military service and flying altered drastically. He exhibited noticeable symptoms of angry defiance and was grounded for four weeks.

After this period, the aviator appeared to improve. He was returned to flying status and from all accounts performed in a competent manner. Six months later, the aviator was flying a helicopter which was observed to pitch up during flight. He immediately went into autorotation and selected a forced landing site. During the flare for landing, the aircraft was seen to pitch up again, strike the ground in a nose-high attitude and rock forward. A main rotor blade flexed down and sheared the tail rotor drive shaft.

The aviator claimed control malfunction as a cause for this accident. However, thorough examination of the aircraft failed to indicate any mechanical difficulties. **Slow rotor rpm, the one condition for which all aviators must be constantly alert, causes the same reactions that were observed during this accident.**

After the accident, the avia-

tor reverted to his former behavior, exhibiting angry defiance and a belligerent attitude. His commander recommended Board action to remove the aviator from military service because of conduct unbecoming an officer. DESPITE ALL THIS, THE AVIATOR REMAINED ON FLIGHT STATUS.

ACCIDENT NO. 4

Sometime later, this same aviator was refused a direct cross-country clearance because of bad weather. He filed a VFR flight plan for a circular route to avoid the weather, and this was accepted. Four hours after takeoff, the aircraft was found demolished in mountainous terrain, 40 miles from the circular route and on a direct line to his destination. The circular route had been filed only to gain his clearance and the aviator flew direct, despite weather warnings and unsuitable terrain. This aviator is now beyond all Board actions or the psychological assistance which might have helped him survive his emotional upheaval.

CAUSES

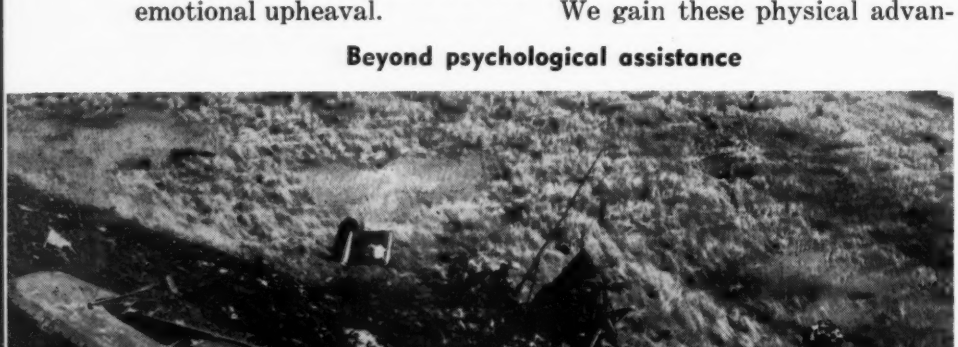
Causes for emotional disturbances are not always so clearly defined as divorce, the death of a loved one, or facing an evaluation Board. They come from any emotion such as fear, grief, rage, or joy and range from these extremes through temporary minor frustrations.

RESULTS

Emotions affect our physical and mental capabilities. The stronger the emotion, the more violent the reaction. In the grip of a strong emotion, the physiological functions of our bodies, including even blood chemistry, change. Internal glands spring to action and tone our hearts, lungs, and muscles to their highest peak of efficiency as a result of adrenalin pumping into our bloodstreams. When this happens, we can run faster, hit harder and feel less pain; our blood will coagulate faster if we are angry. These are well on the plus side of the ledger during emergency situations, but . . . .

The ledger must be balanced. We gain these physical advantages at the cost of effective mental activities. As our bodies funnel their resources to peak physical abilities, our minds are dulled by a starvation diet. When our emotions are aroused, we are incapable of clear thinking. **A joint checking account works fine until one party draws out more than his share. When this happens, checks drawn by the other party are likely to bounce.**

Beyond psychological assistance



ACCIDENT NO. 5

STOMACH CRAMPS

An Army Aviator took off in a Sioux to transport a civilian engineer to a pinnacle landing site. Arriving at the landing site, the aviator made three practice approaches in different directions, then set up his landing approach. The approach was slightly steeper than normal. The pilot noted that he was too high, increased his rate of descent and arrived over the intended touchdown point with some remaining forward speed. He elected to go around and applied full pitch and power. The helicopter moved forward and the main rotor blades struck trees on each side of the go-around lane. The aviator maintained control, flew to the nearest airstrip and landed to check for damage. Major damage to both main rotor blades was discovered.

INVESTIGATION AND ANALYSIS

During the accident investigation, it was revealed that the aviator had suffered from diarrhea on the morning of the accident. He had been awakened at 0200 hours by cramps which kept him awake until approximately 0630 hours.

Asked why his illness had not

VFR flight plan, IFR weather

been mentioned to the chief of air section, the aviator reported a personality conflict between himself and the chief. This conflict had been going on for a number of months. A reviewing flight surgeon stated: "It is difficult to say whether the pilot's physical condition actually caused the accident, but certainly it played a major role."

ACCIDENT NO. 6

OVERCONFIDENCE

A Bird Dog aviator, on a ferry flight, was given a weather briefing which indicated a frontal system adjacent to his route. The aviator took off and flew into worsening weather conditions for 1 hour and 55 minutes without monitoring en route weather advisories or attempting to make radio contact with any facility to report his position or inquire about the weather along his route. The aircraft flew into the clouds; he made a 180° turn and flew for an estimated 10 minutes, but did not break out. The noninstrument rated aviator heard another aircraft report that it was at 7,000 feet between layers of clouds; he began a climb to reach that altitude. The aircraft encountered icing conditions at 6,700 feet. Ice built up rapidly and the engine began losing power. The aircraft descended 1,000 feet and the engine stopped. The aviator bailed out and reached the ground uninjured. The aircraft was destroyed.

It would appear that an experience of this sort would shake some of the confidence from even an overconfident pilot. This is not so in this case, because

ACCIDENT NO. 7

Some 3 months later, this same aviator, flying an LC-126 on a cross-country with a copilot aboard, attempted a night landing at an unlighted airfield. The aircraft struck a tree and telephone wires during final approach, crashed and was demolished. The pilot was killed and the copilot suffered serious injuries.

Interviewed in the hospital, the copilot reported that the aircraft arrived over the airport at about 1845 hours; it was quite dark. The pilot decided to land and started a traffic pattern to the left. The copilot said it became darker and darker as they descended until he could no longer see the strip and suggested to the pilot that he go around. The pilot's comment was, "No sweat." Suddenly the aircraft struck the tree.

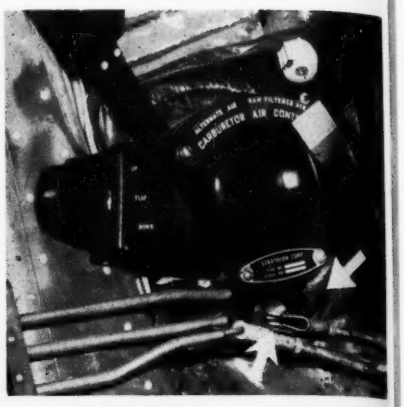
NEAR-ACCIDENT

CARBON MONOXIDE

An L-19 pilot landed at Fort Bragg on 1 June 1960 after a flight from Fort Monmouth and reported that he had fallen asleep en route. The aircraft was test flown and checked for carbon monoxide, which was found to be at a dangerous level. A camera port in the bottom of the fuselage, just aft of the rear seat, was closed. The aircraft was test flown and another carbon monoxide test was made with negative results.

"No sweat"

IT COULD HAPPEN TO YOU



Clevis, throttle separation

It has been recommended that CRASH SENSE include a regular des ription of an accident or a near-accident entitled "It Could Happen To You." Starting with this issue, it will become a regular feature. If you have experienced an incident of this type, the details of which might benefit your fellow aviators, please write it out and mail it to: Editor, ARMY AVIATION DIGEST, Fort Rucker, Ala. Shakespearean prose is not required—just give us the details and we'll do the rest.

A student pilot, flying a Bird Dog on downwind leg for a strip approach, found that he could maintain only 1500-1700 rpm. He was at an altitude of 650 feet indicated and the aircraft was descending at 200 fpm.

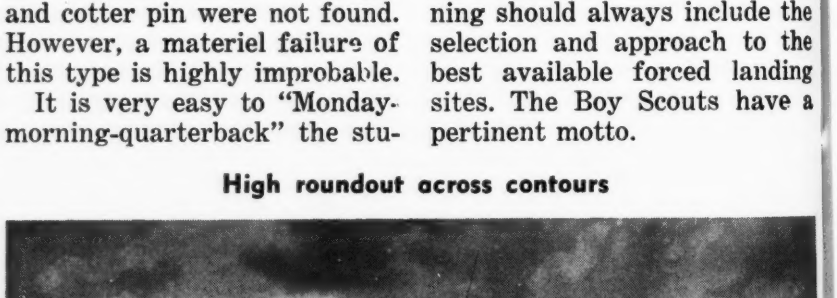
The student pilot selected the largest field he could see and set up an approach. When he felt he had the field made, he cut the engine with the mixture control, lowered 45° flaps and rounded out high. The aircraft touched down on the left main gear, rolled forward and the right gear touched down. It rolled forward across the field contours and the right gear collapsed. The aircraft skidded to a stop in an upright position.

Investigation proved that the clevis pin (P/N AN 393-11) and cotter pin (P/N AN 380-3) were missing. The clevis was separated from the throttle control. In this condition, the carburetor butterfly valve wili go to an approximate half open position, resulting in an rpm of 1300-1500.

Checking maintenance records, it was found that the throttle control cable had been removed and replaced on the previous day. It is impossible to say whether improper installation or materiel failure caused this condition, as the clevis pin and cotter pin were not found. However, a materiel failure of this type is highly improbable.

It is very easy to "Monday-morning-quarterback" the student pilot's mistakes during the forced landing—he made a crosswind approach, across the contours of his selected field, rounded out high and allowed the aircraft to drop in. Let's remember that this was a student pilot with a total of 178 flying hours. Obviously engrossed with the strip approach, he was suddenly faced with the necessity for a forced landing at an altitude of 650 feet indicated. This left him little time to select a field, go through his forced landing procedures and set up a good approach. Let's also remember that strip planning should always include the selection and approach to the best available forced landing sites. The Boy Scouts have a pertinent motto.

High roundout across contours



Potential Engine Failure

THE ARMY is studying the safety application of a spectrometer device which detects impurities in aircraft engine oil to warn of engine defects in their early stages.

This process, developed by the U. S. Navy, is credited with prevention of serious inflight engine failures. The spectrometer determines the identity and quantity of metals in the engine oil. A one-ounce sample of oil is taken from the engine reservoir within 15 minutes after landing and is burned between two carbon electrodes in a direct reading spectrometer which identifies the metals and measures their quantities.

The Naval Air Station, Pensacola, Fla., has agreed to test oil samples from 20 Army H-34 helicopters at 15-hour flight intervals. TATSA, U. S. Army Aviation Center, Fort Rucker, Ala., will conduct the evaluation to develop specific procedures and requirements for incorporating a program similar to the Navy's.

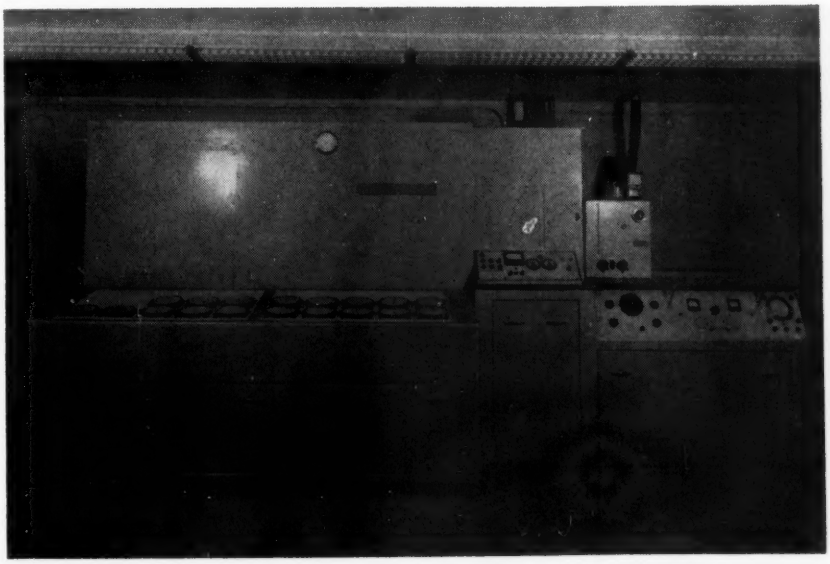
The spectrometer is capable of measuring and identifying the amounts of iron, aluminum, tin, silicon, chromium, lead, copper, nickle, or silver in the oil. The metal and its quantity may determine the engine defect and its probable location. For instance, a high concentration of silver in the oil indicates a faulty bearing; a large amount of chromium usually denotes cylinder wall damage; and large amounts of aluminum can mean piston or valve guide failures.

The Navy has been using the spectrometer for about two years, and indications of engine defects have been accurate more than 90 percent of the time. At least one Army H-34 engine defect already has been detected after the Navy's spectrometer indicated high metal content in the oil.

The spectrometer technique was successfully adapted for aircraft engines from a method which has been long used by railroads and other operators of diesel equipment to detect metal content in oil.

The Navy believes similar methods are theoretically applicable to gas-turbine engines and presently is studying this concept.

Forecast by Machine?



Operation Amigos

IN THE WAKE of Chile's recent series of earthquakes and devastating tidal waves, U. S. Army air ambulances flew more than 4,000 miles in less than a week while conducting mercy missions in the wind- and rain-swept disaster areas.

Ten HU-1A helicopters, flown in by MATS C-124 cargo carriers for Operation Amigos, were accompanied by two complete ambulance units. The 56th Medical Detachment (Helicopter) from Fort Bragg, N. C., and the 57th Medical Detachment (Helicopter) from Fort Meade, Md., were supported by the 25th Transportation Army Aviation Maintenance Company from Fort Bragg.

The Army air ambulance units were airlifted on the first day of the operation which rushed nearly 1,000 tons of Department of Defense relief aid to Chile.

Eight of the ten helicopters followed the U. S. Army's 15th Field Hospital from Fort Bragg into Puerto Montt, where a new 6,000-foot runway accommodated the cargo planes for landing and rapid unloading and deployment of supplies and personnel.

The local hospital at Puerto Montt was demolished by the quake and Chilean medical personnel were operating in a field house. The 15th Field Hospital set up in the adjacent football field. The 7th Field Hospital operated from flood-threatened Valdivia with two helicopters.

Planes of the U. S. and Chilean Air Force evacuated the more seriously injured to Santiago. Tremors continued to rock the area for days.

Volcanic smoke and ash combined with the already poor weather conditions to compound the difficult rescue operations. Only sketchy information was known of the situation in the outlying districts. A tidal wave had lashed the coastal regions, and subterranean upheavals had caused unknown islands to form and known islands to disappear under the sea. The altered topography of a strange country presented complex navigation and identification problems.

In spite of these obstacles, over 200 patients were treated and more than 600 examined and vaccinated by U. S. Army medical units in the first three days of the operation. During that time the HU-1As hauled approximately 8½ tons of relief supplies to remote regions.